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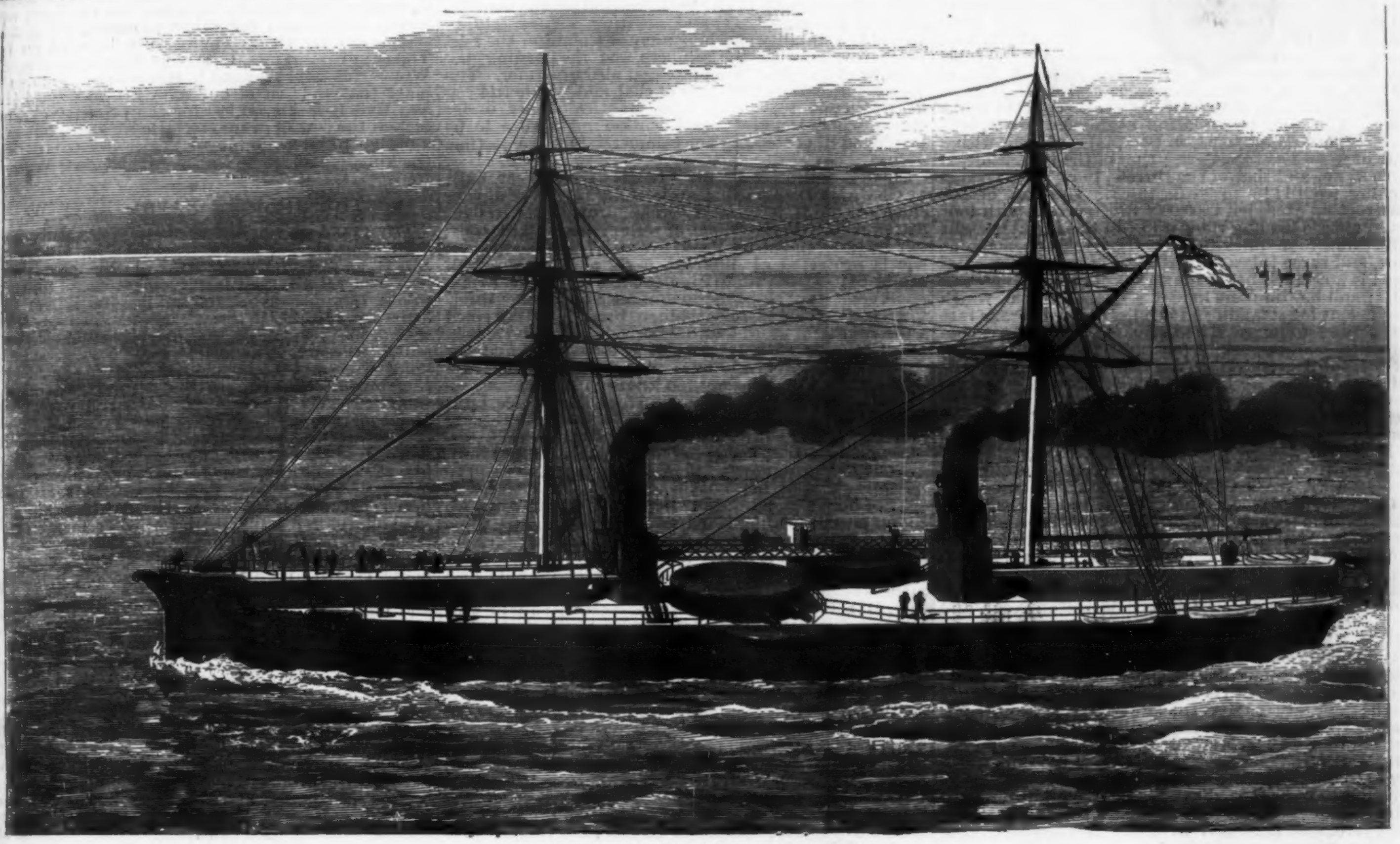
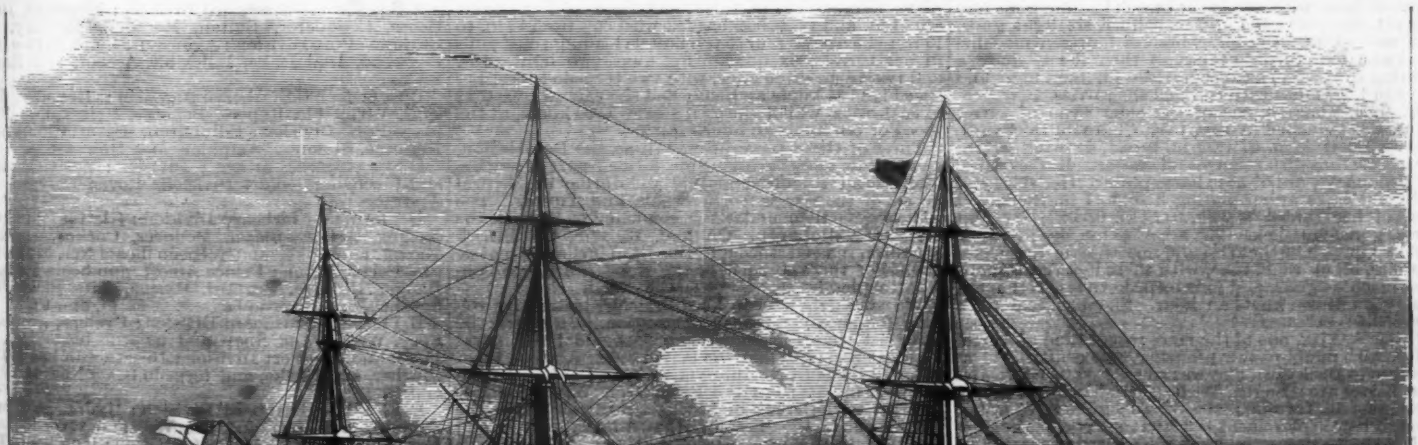


H. M. S. INFLEXIBLE (FLAGSHIP).



H. M. S. MONARCH.

THE QUEEN'S JUBILEE NAVAL REVIEW.

SHIPS AT THE QUEEN'S JUBILEE NAVAL REVIEW.

H. M. S. Inflexible, the flag-ship of Admiral Sir George Willes, K.C.B., who commanded the fleet assembled July 23, 1887, at Spithead, to be reviewed by her Majesty the Queen, was built at Portsmouth Dockyard, from the designs of Sir Nathaniel Barnaby, then Director of Naval Construction, and was launched in April, 1876, Princess Louise, as representative of the Queen, taking the chief part in the ceremony; but this ship was not finally completed till 1881. The Inflexible was considered the greatest result that had been obtained by the naval architects of the Board of Admiralty; one of the most important, novel and peculiar features in her design being the citadel, or castle, fore and aft, the sides of which, having a length of 110 ft., rise to a height of 20 ft. above the water, and are joined by transverse walls 75 ft. long, across the deck; the turrets, moreover, instead of being placed on the direct line of the keel, are placed obliquely, one looking to the port side and the other to starboard. This great ship is 320 ft. long, 75 ft. broad, and draws 25 ft. 5 in. water, her displacement being no less than 11,880 tons. Her engines, constructed by Messrs. Elder & Co., of Glasgow, are of 8,000 horse power, and each is completely isolated, so as to work if the other engine broke down. The side armor plating, at different parts, is 16 in., 20 in. and 24 in. thick, in two plates of iron, with a mass of wood between them; that of the bulkheads, 14 in. to 22 in., and that of the turrets, 16 in.; the wooden backing from 17 in. to 25 in. thick. The cost of her construction exceeded £800,000. She is armed with four 80-ton muzzle-loading rifled guns, in the turrets; eight light guns, four quick-firing guns, seventeen machine guns, and three tubes for discharging torpedoes. Her speed is not much below fourteen knots or sea miles an hour; and her bunkers hold 1,300 tons of coal, which is sufficient for steaming 5,200 miles at the average rate of ten miles an hour. The Inflexible, it will be remembered, took an important part in the bombardment of the forts of Alexandria, on July 12, 1882, as did also the Sultan and the Invincible, which are described on another page.

H. M. S. Agincourt, a broadside ship of war, constructed at Birkenhead by Messrs. Laird, in 1868, is 400 ft. in length and 59 ft. 6 in. broad, draws 27 ft. 9 in. water, with a displacement of 10,690 tons; the engines, by Maudslay, are of 6,870 horse power; the armor is comparatively slight, being only 4½ in. and 5½ in. thick on 10 in. oak backing. This ship's broadside fire is of eight 12-ton guns on each side, having seventeen guns of that size in all, with fourteen light guns; and she is furnished with fifteen machine guns, for defense against boarding, and with a couple of torpedo tubes. Her speed is more than fourteen knots an hour, and she has coal for steaming 1,300 miles.

H. M. S. Minotaur, likewise a broadside man-of-war, of the same period, built at Blackwall by private contract, is of the same dimensions with the Agincourt; the armor plating also is similar to that; and the guns are the same, except that the Minotaur has two breech-loading rifled guns of six-inch caliber, and has also four torpedo tubes. The Minotaur has rather higher speed.

H. M. S. Hercules is a central battery ship, much larger than the Invincible, her dimensions being 325 ft. long and 59 ft. broad; she draws 26 ft. 6 in. water, with a displacement of 8,680 tons. She was built at Chatham Dockyard, and launched in 1868. Her engines, made by Penn & Sons, are of 6,750 horse power. The armor plating is six and nine inches thick. The battery consists of eight heavy guns, breech loaders, each weighing eighteen tons, with two lesser breech loading guns fore and aft, also four guns of 7 in. caliber, six light guns, and two quick-firing guns, besides fourteen machine guns and four torpedo tubes, so that she is quite a fighting ship. She steams fourteen knots an hour, and can run 1,760 miles with the coal she carries.

H. M. S. Monarch, one of the older type of turret ships, was launched in 1869, from Chatham Dockyard, and is 330 ft. long, 57 ft. 6 in. broad, drawing 27 ft., with 8,320 tons displacement of water. Her engines, by Humphrys, are of 7,840 horse power. Her sides and bulwarks have armor plating 5 in. to 7 in. thick, and that of her turrets is 8 in. to 10 in. thick. Her four turret guns, muzzle-loading, are of 25 ton size; and she has two guns half that size and one that is a quarter the size, all of rifled bore, with three light guns, fourteen machine guns, and four torpedo tubes. Her speed is close on fifteen knots an hour. She has coal for a run of 1,500 miles.

H. M. S. Ajax, one of the more recent kind of turret ships, with double screw propeller, was constructed at Pembroke Dockyard, and was completed in 1883. Her dimensions are: length, 280 ft.; breadth, 66 ft., giving handiness in turning; she draws but 24 ft. of water, though her displacement is 8,510 tons. She has engines of 6,440 horse power, by Penn; her speed is nearly 13½ knots, and her "coal endurance" will support a voyage of 4,100 miles. Her turrets are armed with four guns of 38-ton size (muzzle loading, of course), and she possesses also two breech loaders of six-inch bore and two light guns, with fourteen machine guns, and a couple of tubes for torpedoes.

H. M. S. Collingwood is a ship of the new Admiral class, with barbette-mounted guns, which are placed 22 ft. above the water, on fixed towers standing 140 ft. apart, besides having a large unarmored battery, of six-inch breech loaders, at ports 8 ft. below the towers, still above the ordinary deck of the ship, with much convenience for the crew and facility of working. A volume by Lord Brassey, just published, "The Naval Annual for 1886," contains valuable remarks upon the advantages of this type of ship, compared with such as the Devastation and the Inflexible; and the very satisfactory steaming trials of the Collingwood are noted. This ship, built at Pembroke Dockyard, was launched last year having cost nearly £600,000. She is 325 ft. long, and has a breadth of 68 ft., drawing 26 ft. 3 in. water, with displacement of 9,150 tons. Her engines, by Maudslay, have no less than 9,570 horse power, and she has two screw propellers. The armor plating on her sides is 16 in. and 18 in. thick, and that of the barbette towers 12 in. and 14 in. thick. She carries, like the Colossus, a sister ship, four breech-loading rifled guns of 43-ton size, with six lesser breech-loaders, and with 12 quick firing guns, which should make her tolerably effective in battle; she is also furnished with the usual allowance of machine guns, and with four torpedo-launching tubes or stands. The speed of the Collingwood is more than sixteen and a half knots an hour, 16·40, but may possibly be excelled by several other new twin screw ships, the Benbow, the Camperdown, and the Anson, with barbette-mounted guns. These ships carry 1,200 tons of coal, good for a voyage of 8,500 sea miles.

H. M. S. Imperieuse, an armor-belted twin-screw cruiser, represents also some of the latest improvements, and has a speed of 17 knots an hour. She carries four 18-ton breech loading guns on armored barbette towers, and six breech-loaders of six-inch caliber, with four light guns and four quick-firing, also fourteen machine guns and six torpedo tubes. She is 315 ft. long, 62 ft. broad, and draws 25 ft., with 7,390 tons displacement, and the hull is sheathed with copper. The Imperieuse was built at Portsmouth, and was finished last year. Her engines, of 10,180 horse power, were constructed by Maudslay's firm, and are highly commended. The armor plating is from 8 in. to 10 in. thick, and is mainly applied in a belt extending two-fifths of the length of the hull, protecting the machinery and the magazines, and assisting, we are told, to secure the stability and buoyancy of the ship; the barbette towers, with the gunners and the loading machinery of the guns, are protected also by armor. The Imperieuse carries 1,200 tons of coal, and is able to keep at sea while traversing 7,300 nautical miles under steam, which is a great qualification for a ship to be employed in protecting our commercial marine in time of war.

H. M. S. Sultan is a central battery ship of war, built at Chatham Dockyard, completed in 1871; her dimensions are 325 ft. long, 59 ft. broad, drawing 27 ft. 6 in. water, with a displacement of water equal to 9,200 tons; her engines, made by Penn, are of 7,720 horse power; she is protected at different parts of her sides with armor plates from six to nine inches thick; her armament consists of eight 18-ton muzzle-loading rifled guns, four 12½-ton guns, seven 4-inch breech-loading rifled guns, four light guns, four quick-firing guns, and eleven machine guns, with five tubes for torpedoes; and her speed is 14·13 knots an hour; she carries coals to steam 2,140 knots at the speed of ten knots an hour.

H. M. S. Glatton is a turret-ship for coast service, built at Chatham, and completed in 1872; she is 245 ft. long and 54 ft. broad, drawing 19 ft. of water, with a displacement of 4,910 tons; her engines, made by Laird, are of 2,870 horse power; her turret armor is 18 in. or 20 in. thick, that of her bulkheads 12 in. and 14 in., and that of her sides, 10 in. or 12 in.; she is armed with two 25-ton muzzle loading rifled guns, two light guns, three quick-firing guns, four machine guns, and two torpedo tubes; her speed is nearly thirteen knots an hour, and she has coal for steaming two thousand knots at a moderate speed.

H. M. S. Invincible is a central battery ship of war, built at Glasgow by Messrs. Napier, finished in 1870; she is 280 ft. in length and 54 ft. in breadth; she draws 22 ft. 9 in. water, and her displacement is 6,010 tons; her engines are of 4,830 horse power; she has armor plates of 5 in., 6 in. and 8 in. thickness; her armament consists of ten 12-ton muzzle-loading rifled guns, six 4-in. breech-loading rifled guns, four light guns, four quick-firing guns, fifteen machine guns, and four torpedo tubes; her speed is above fourteen knots an hour; and she can steam, at the rate of ten knots, a distance of 1,580 knots at sea.

H. M. S. Devastation is a turret ship, built at Portsmouth Dockyard, completed in 1873; her length is 285 ft., breadth of beam, 62 ft. 3 in.; she draws 27 ft. 6 in.; her displacement is 9,330 tons; her engines, made by Penn, are of 6,650 horse power; her sides have armor plates 12 in. and 10 in. thick, and those of her turrets are 14 in. and 12. thick, backed with oak from 15 in. to 18 in.; she carries four 35-ton muzzle loading rifled guns in her turrets, six quick-firing guns, two light guns, and twelve machine guns, with two torpedo tubes; her speed is 13·84 knots an hour; and she carries 1,800 tons of coal, with which she can steam 5,980 knots, at the speed of ten knots an hour.

Three of these powerful war ships, the Devastation, the Sultan, and the Invincible, formed part of our Mediterranean squadron in 1876 and during the critical period of the war between Russia and Turkey. The Sultan was then under the command of H. R. H. the Duke of Edinburgh. On Feb. 13, 1878, the British squadron passed through the Dardanelles, in consequence of the approach of the Russian army to Constantinople.

We can safely refer to Lord Brassey's instructive volume for much further information. It should be observed that the Imperieuse class and the Admiral class of new ships, and the belted cruisers, are of types adopted by Lord Northbrook, as First Lord of the Admiralty, in 1884; but the Right Hon. W. H. Smith is entitled to the credit of having already laid down the Collingwood, the first of the Admiral class, and Lord Brassey cordially bears testimony to the merits of his administration. "Let there be less of national self-depreciation and less of party spirit in dealing with the navy," says Lord Brassey, with whom, it is to be hoped, the spectators of the naval review at Spithead will be disposed to agree.

As it is a Queen's jubilee review, this occasion is appropriate for noticing the progress that has been made, both in the construction and equipment of our war ships and in the manufacture of naval ordnance, since her Majesty's accession to the throne. In 1837, our navy consisted of wooden unarmored sailing ships; only two first-rate, carrying 120 thirty-two pounder guns, with two sixty-eight pounder carronades; four second-rate ships of 96, 84 and 72 guns; and eleven third-rate, for line of battle; with frigates, brigs, and sloops of war and a few non-combatant steamers. In 1837 there was a first-class line-of-battle ship named the Trafalgar building at Woolwich Dockyard; and now, in 1887, there is another first-class ship, also to be named the Trafalgar, building at Portsmouth. Let us compare these two ships. The old Trafalgar, constructed of wood, was 205 ft. long, 55 ft. 7½ in. broad, and would carry 120 guns, each of the average weight of 45 cwt., throwing projectiles of 16½ lb. weight on the average. She required a crew of 1,000 men to work the sails and guns, all being then done by manual labor, without the aid of machinery. The new Trafalgar, built entirely of steel, and the hulk subdivided into 150 watertight compartments, is 345 ft. long, 73 ft. broad, and will have a displacement of 11,940 tons. Her triple expansion engines, with cylindrical boilers, working up to 135 lb the square inch, will develop 12,000 horse power, which will drive the ship at a speed of nearly seventeen knots an hour; and she will carry sufficient coal supply to steam 2,000 knots at full speed or 7,700 knots at the speed of ten knots an hour. This new war ship, the Trafalgar of the present day, will be armored with steel-faced plates from 14 in. to 20 in. thick; she will carry, in her two revolving armored turrets, four 67-ton breech-loading rifled guns, which discharge projectiles weighing 1,250 lb., with 520 lb. powder charges; and she will also carry eight lesser guns, but of immensely greater power than any of 1837, nineteen quick-firing guns, and apparatus for charging and launching torpedoes. It is considered that the new Trafalgar, with her defenses and her powers of offense, "would alone be more than a match for the whole of the British navy in 1837, being absolutely invulnerable to their means of attack." As all the necessary operations for working the ship, steering and fighting, will be performed by steam, the crew will number but 520 men, only about half the crew of the old Trafalgar. Hydraulic machinery will be employed in working the turrets, the guns, the shot and ammunition hoists, and for other purposes, while fifty or sixty auxiliary steam engines will be used on board. The ship will, in fact, be a huge floating war machine. Wonderful improvement! But let us not omit the remark that the cost of our navy in 1837 was £4,419,700, and that it is £12,741,000 for the present year, not to reckon the cost of ordnance. Do we seem, however, as a nation to be grudging or neglecting the defense of the kingdom at sea?—*Illustrated London News.*

THE JUBILEE NAVAL REVIEW.

THE grand naval review at Spithead, July 23, 1887, when the Queen, in the royal yacht Victoria and Albert, passed along the lines of the most powerful fleet ever yet assembled, was a magnificent and appropriate termination of the jubilee festivities in this fiftieth year of her Majesty's reign. The weather was as bright and fair as an English summer day can afford; the arrangements, which we described beforehand, were most convenient, and were effectively carried into execution; and the gathering of spectators was the largest that has ever taken place on such an occasion. The fleet which her Majesty had the pleasure of showing to the numerous royal and distinguished personages who followed her yacht in its progress comprised every description of ironclad and modern instrument of warfare that floats upon the sea. It numbered 135 vessels, including twenty-six armored and nine unarmored ships, three torpedo cruisers, one torpedo gun-boat, one gun and torpedo vessel, thirty-eight first class torpedo boats, thirty-eight gun-boats, twelve troop ships, one paddle frigate, and six training brigs. The total complement of officers and men was 20,200, and of guns about five hundred; but the immense power of the great ships and of the ordnance puts this naval review out of all comparison with previous reviews, which may have collected a larger number of vessels.

The whole fleet, under the command of Admiral Sir George Willes, K.C.B., was divided into three cruising squadrons, A, B, and C, and was moored at Spithead in columns of divisions in line ahead, the ships at two cables apart and three cables apart, with the flagships of each squadron to the eastward. There were also formed in columns of divisions in line ahead (parallel to and inshore of A, B, C squadrons) five distinct coast-defense flotillas, each consisting of coast-defense ships, gun-boats, and torpedo-boats. The formation and strength of the several squadrons and flotillas were as follows:

A Squadron.—Starboard Division: Minotaur, Imperieuse, Conqueror, Sultan, Monarch, Mercury, and Curlew.—Port Division: Agincourt, Black Prince, Collingwood, Iron Duke, Inflexible, Archer, and Rattlesnake.

B Squadron.—Starboard Division: Hercules, Hotspur, Invincible, Rupert, Belleisle, Mersey, and Fearless.—Port Division: Edinburgh, Devastation, Ajax, Neptune, Shannon, Amphion, and Mohawk.

C Squadron.—Starboard Division: Active, Volage, and Inconstant.—Port Division: Rover, Calypso, and Arethusa.

D Flotilla.—Starboard Division: Glatton, gun boats Medina, Arrow, Blazer, Bouncer, Cuckoo, Insolent, Mastiff, and Pike, and torpedo boats Nos. 31, 34, and 62.—Port Division: Prince Albert, gun boats Medway, Badger, Bonetta, Bustard, Hyæna, Kite, Pickle, and Staunch, and torpedo boats Nos. 32, 61, and 63.

E Flotilla.—Starboard Division: Cyclops, gun boats Spey, Weazel, and Snap, and torpedo boats Nos. 41, 45, 48, and 50.—Port Division: Hecate, gun boats Tees, Pincher, and Snake, and torpedo boats Nos. 44, 46, 49, and 42.

F Flotilla.—Starboard Division: Hydra, gun boats Sabrina, Bull Dog, and Scourge, and torpedo boats Nos. 26, 70, 33, and 38.—Port Division: Gun boats Fay, Plucky, and Fidget, and torpedo boats Nos. 35, 72, 37, and 30.

G Flotilla.—Second Division: Gorgon, and torpedo boats Nos. 59, 51, 53, and 56.—Port Division: Torpedo boats Nos. 60, 52, 55, and 58.

H Flotilla.—Bramble, Slaney, and Trent, and torpedo boats Nos. 27 and 26.

The following commentary on the respective qualities of the most important ships is borrowed from a correspondent of the *Daily News:* At what may be termed the eastern gate of the waterway, each side of which was lined with battle ships, were anchored the Minotaur and Agincourt—one bearing the flag of Admiral Sir W. Hewitt, V.C., the other that of Rear-Admiral the Hon. E. Fremantle, C.B. These five-masted ironclads are the most imposing in appearance of all our modern men-of-war, but the metal from one of their broadsides would not weigh much more than two shots from the Inflexible eighty-tonners, and, for defensive purposes, their iron-plated sides would not long resist the shock of modern artillery. We had time to note the beautiful proportions, the towering masts, and slender top spars of the Black Prince, oldest and least powerful, but by far the most graceful of all the great war ships here assembled. Opposite her lay the Imperieuse, a swift ocean cruiser, partially protected by an armor belt in the middle, with four 18 ton guns en *barbette.* Next, anchored abreast, were two of the most modern and powerful types, the Conqueror, with its low freeboard forward, its high poop astern, and its torpedo boats hoisted inboard, looking like huge whales, and the Collingwood, which carries its great

44-ton guns mounted in revolving barbette towers fore and aft. The latter has one bare pole, called a military mast, with double tops for machine-gun crews, and, in this respect, differs from all other ships of the armada. Her broadside bulwarks bristle with quick-firing guns, and her principal pieces of ordnance, shaped like enormous bottles, can be made to cover the whole circle of sea round about her. The Sultan, one of the most powerful of our broadside ironclads, lies at anchor opposite the Iron Duke, which gained unenviable notoriety once upon a time by ramming the Vanguard. The Sultan was one of the ships that played its part well under Sir Beauchamp Seymour in the bombardment of Alexandria, and just astern of her lies the Monarch, whose shots made deep scars in the fortifications that were manned by Arabi's Egyptians.

Opposite the Monarch, in the port division, is anchored the Inflexible, with the muzzles of her formidable 80-ton guns grinning through the dark portholes of her turrets. Those guns, belching out 1,700 lb. of iron at every shot, reduced Fort Pharos to silence before noon; and the mark of their missiles may still be seen deeply indenting the walls of that stronghold. The fast cruiser Mercury represents quite another type, but one not less important for modern warfare than armored ships. She can steam just nineteen knots an hour with ease, and on her trial trip from Portsmouth to Portland she covered the sixty knots in less than four hours. The torpedo fleet to which she happened to give chase in broad daylight, or with no friendly haven close at hand, would have a very bad time of it. Beyond the Archer, in the port line, lies the mischievous-looking Rattlesnake, which is a torpedo boat for attack, but preys on her species by becoming a torpedo catcher when in the mood. Of this type our most scientific and enterprising men would gladly see a hundred added to the British navy. The Hercules, sister ship to the Sultan; the Edinburgh, a very powerful fighting ship; the Devastation, whose puissance is still to be dreaded by the foes of England; the Ajax, unwieldy in maneuvers, but mighty in battle; and the Invincible, on board of which Sir Beauchamp Seymour hoisted his flag at Alexandria, find many admirers. The Neptune, one of the cheapest purchases from a private firm, though bought during the panic of a threatened war, lies abreast of another turret ship, the Rupert. Astern of them come squadrons of corvettes and fast cruisers, with a few line-of-battle ships, but none of modern type among them. Passing by them, we emerge on clear water at the western end of the line.

Soon after three o'clock in the afternoon, all the vessels appointed to take part in the royal procession having assembled on the Isle of Wight side, the royal yacht Alberta, drawing less water than the Victoria and Albert, was seen coming from the direction of East Cowes. At her foremast head was flying the Admiralty flag, a red banner with a yellow anchor denoting that the Lords of the Admiralty were on board. The royal standard at the main showed that the Queen was afloat and at the mizzen was a Union Jack, the flag always used by crowned heads in this country as a dressing flag, instead of a white ensign. As soon as the yacht was perceived from the decks of the assembled transports, guards of marines were turned up, the flags dipped, and anchors weighed. Among those on board the royal yachts, in addition to the Queen, were the Duke and Duchess of Connaught, Prince and Princess Christian, Prince Henry of Battenberg and Princess Beatrice, the Duchess of Albany, the Crown Prince and Princess of Germany and daughters, the Duke and Duchess of Teck, the Comte de Paris, the Duchess of Mecklenburg-Strelitz, the Crown Prince and Princess of Portugal, and Princess Eulalie of Spain, the Prince and Princess of Wales and the young princes and princesses, with the King of the Hellenes and Prince Henry of Prussia. Some little time was occupied by the removal of the royal party from the Alberta to the Victoria and Albert, the flags which had been flying in the smaller yacht having been transferred to the larger one as soon as her Majesty had gone aboard, white ensigns being hoisted in their place.

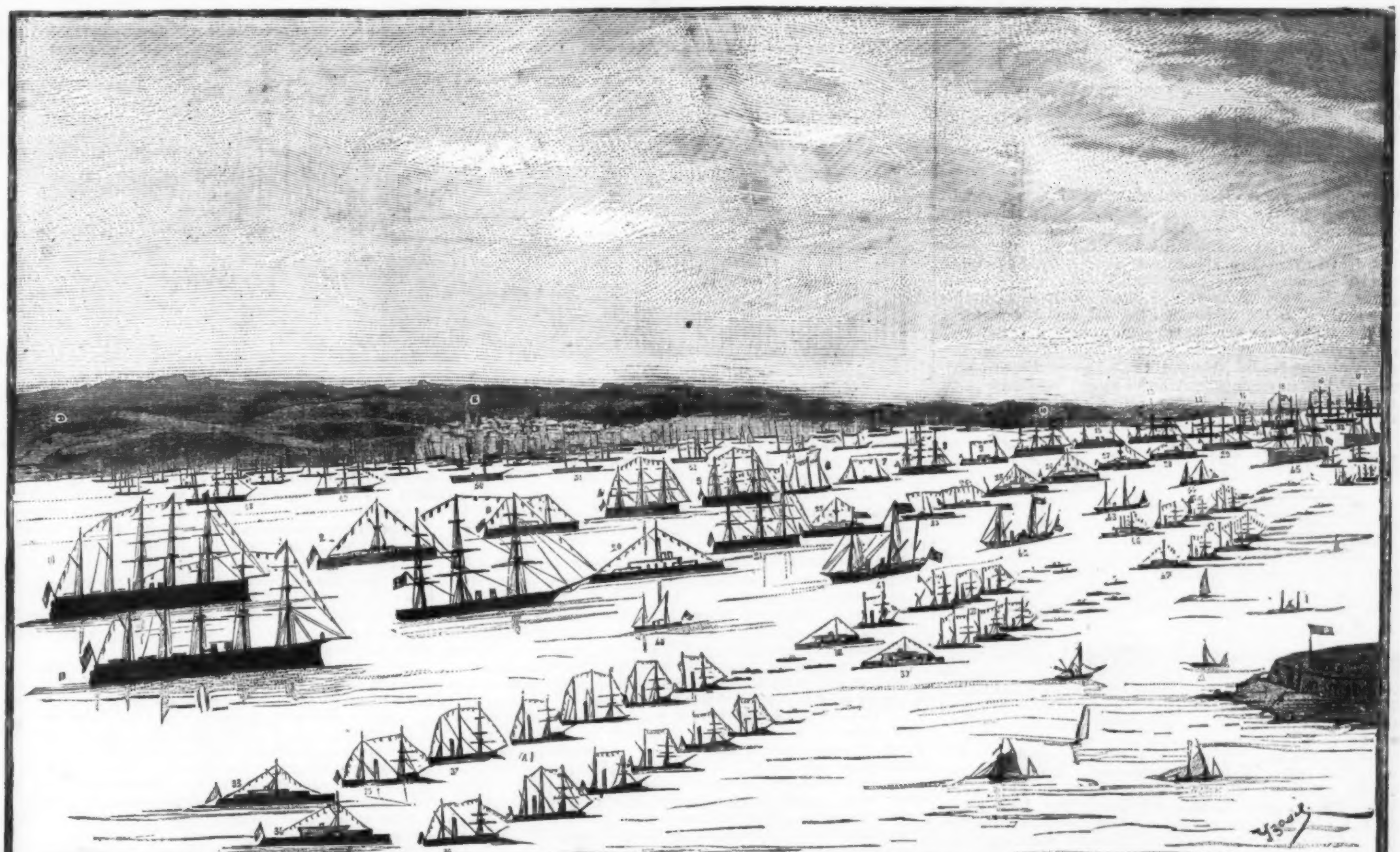
This being accomplished, precisely at twenty-five minutes past three the Victoria and Albert started in the direction of the fleet, preceded at about four hundred yards distance by the Galatea, the yacht of the Trinity House, with the Elder Brethren aboard, piloting the way. After about the same interval, which separated all the following ships, the Osborne steamed along, with the standards of the Prince of Wales and the King of the Hellenes still flying. The Alberta came next, and then, in the order named, the Enchantress, with friends of the Lords Commissioners of the Admiralty; the Helicon, with the ambassadors and foreign ministers; the Euphrates, with peers and peeresses; the Crocodile, with members of the House of Commons and their friends; the Malabar, with Indian and Colonial visitors; and, last, the Assistance, with a mixed company, some members of the House of Commons and the Indian and Colonial visitors, and the representatives of the press. The first gun from the Commander in Chief's flagship Inflexible announced that the Victoria and Albert, with the Queen on board, was approaching the fleet. This was the signal for the royal salute of twenty-one guns, and at once every ship that had guns on board began to salute.

The Victoria and Albert soon came abreast of the Agincourt, which lay at the extreme west of the northern line of ironclads. When the guns had ceased to thunder, and the vast clouds of smoke had passed away, it was seen that all the yards of the masted ships and the turrets, breastworks, and decks of the unmasted were manned with hundreds of sailors. Marine guards of honor were placed upon the poops, and before the approaching flotilla was visible one could hear the cheering from the ships far down the lines. As the Victoria and Albert passed slowly by, the eyes of all were looking for the Queen. While the marines saluted, the band played the national anthem, and the commander on the bridge led three hearty rounds of cheering. The Queen sat surrounded by her grandchildren and the ladies of her suite, under an awning on the quarter-deck of her yacht. So close did she pass that the expression on her face was clearly visible to all who had good glasses. Her Majesty looked very well, and smiled graciously as each ship in succession took up the cheering. Following the Victoria and Albert, at a distance of a couple of cables, came the Alberta, and then the Osborne. On board the latter was the Prince of Wales, in his new uniform as honorary Admiral of the Fleet. He was on the bridge, and scarcely took his binocular from his eyes except to make a quick observation to the Princess, who, in her pale cream-colored dress, stood at his side. Some of the Indian visitors in the Malabar were conspicuous by their gay and glittering uniforms. Each vessel as she slowly passed was saluted by the royal marines on the poop.

The Queen's flotilla steamed from west to east between the line of gunboats off the Hampshire shore and the northernmost line of ironclads and cruisers. Instead of immediately turning to the starboard after clearing the ends of these lines, the Victoria and Albert continued her course for a considerable distance, and did not turn for about an hour. On its return the royal flotilla stopped between the columns of ironclads, and came to anchor opposite the Inflexible. The signal was given for Admiral Sir George Willes, with the flag officers and all the captains under his command, to go on board the royal yacht, the Victoria and Albert. The Prince of Wales and the foreign princes also went on board, and a kind of levee was held, the Queen graciously speaking a few words to several officers. Her Majesty then made the following general signal: "Convey to the officers and men under your command that her Majesty has great satisfaction and pride in the magnificent display made by her navy this afternoon." Each captain, on returning to his own ship, read the Queen's message to his assembled crew on the quarter-deck. Several foreign naval officers—French, Dutch, and German—commanding ships that lay near, were received by the Prince of Wales, who presented them to her Majesty. The royal flotilla once more got under way, steaming down the line, while yards were manned, and the big guns thundered out a farewell salute, which was echoed from the forts on shore, and with that the great naval review was at an end.

The illumination of fleet at night was a magnificent display. The showers of red, white, and blue lights looked as if the ships were draped in flags of fire, and the electric lights when thrown upward to form an arch over the fleet might have been seen from fifty miles inland. Thousands of people watched the spectacle from Southsea common. Each ship was lighted by a line of lanterns placed 9 ft. apart along the upper deck from stem to stern, and by rainbows of lamps over the masts. Each ship had also, triced up in her rigging, a monogram of the letters "V.R.," formed of incandescent electric lights. The pattern of the monogram was not prescribed, and scope was thus left for the ingenuity of the officers of the various vessels. The best results were produced by the Inflexible, which had two plain letters traced by brilliant white lamps; and by the Agincourt, which had a monogram that was alike on both sides, and was formed of plain white lamps and others covered with red bunting. When the display of the fireworks began, so much smoke was evolved that very little of the general effect could be seen from any one point. Bouquets of rockets or brilliant salvoes of Roman candles were sent up, with beautiful effects of color, from all the ships. When the fireworks were exhausted the hour was late, and but little time remained for displaying the electric search lights. These were, however, exhibited for a few minutes, each ship throwing a beam upward over the ship abreast of her, the result being the formation of a series of avenues of light. By eleven o'clock the illuminations ended.—*Illustrated London News.*

Our general view is from *Le Monde Illustre.*



1. Minotaur. 2. Imperieuse. 3. Conqueror. 4. Sultan. 5. Monarch. 6. Mercury. 7. Curlew. 8. Hercules. 9. Hotspur. 10. Invincible. 11. Rupert. 12. Belleisle. 13. Mersey. 14. Fearless. 15. Active. 16. Volage. 17. Inconstant. 18. Agincourt. 19. Black Prince. 20. Collingwood. 21. Iron Duke. 22. Inflexible. 23. Rattlesnake. 24. Archer. 25. Edinburgh. 26. Devastation. 27. Ajax. 28. Neptune. 29. Shannon. 30. Amphion. 31. Mohawk. 32. Rover. 33. Glatton. 34. Prince Albert. 35. Medway. 36. Medina. 37. Arrow. 38. Hecate. 39. Cyclops. 40. Galatea (Pilot). 41. Victoria and Albert, yacht of the Queen. 42. Osborne and Albert, yacht of the Prince of Wales. 43. Assistance and Albert, yacht of the Admiral. 44. Helicon, yacht of the Ambassadors. 45-46. Troop Ships conveying the Lords and Commons. 46. Hydra. 47. Gorgon. 50. Jumna. A, B, C. Flotillas of gun and torpedo boats. D. Isle of Wight. E. Ryde, where the yachts of civilians and visitors were located.

THE QUEEN'S JUBILEE NAVAL REVIEW—THE ROYAL CORTEGE PASSING BETWEEN THE NAVAL SQUADRONS.

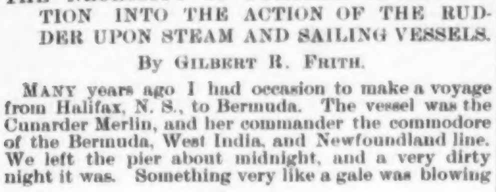
FLAT turnips constitute one of the best crops to raise in a garden after an early crop has been secured. A use can be found for them in the house as well as the barn.

THE NECESSITY OF FURTHER INVESTIGATION INTO THE ACTION OF THE RUDDER UPON STEAM AND SAILING VESSELS.

By GILBERT R. FRITH.

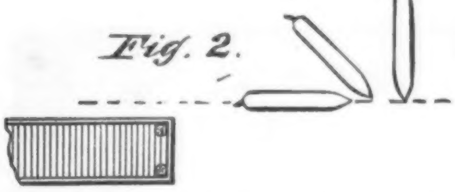
MANY years ago I had occasion to make a voyage from Halifax, N. S., to Bermuda. The vessel was the Cunarder Merlin, and her commander the commodore of the Bermuda, West India, and Newfoundland line. We left the pier about midnight, and a very dirty night it was. Something very like a gale was blowing

Fig. 1



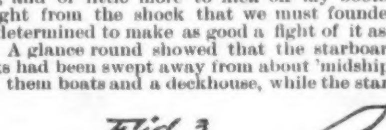
from E.N.E., with fitful storms of rain. We made a good start, however, and in an hour and a half had steamed past Sambro Light, some 12 or 14 miles from Halifax, and the dangerous, stony-hearted group, the Sisters, with whom mariners care not to have even a bowing acquaintance (no pun intended), were holding their storm revels not far away. From the time of leaving the wharf, I had remained in shelter from the rain, under the main companion, smoking, and enjoying the scene—if scene could be called what was dimly visible on so dark a night. Suddenly a rush of

Fig. 2.



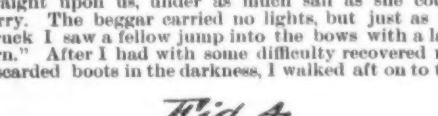
feet on deck, an excited outcry, and then a tremendous crash on our starboard side. Simultaneously an immense white spectral object towered high above us, and instantly vanished astern into the darkness, while down upon the stout hatchway—the half-dome beneath which I stood—rattled blocks and broken rigging. It was the work of a moment to jump on deck, and of little more to kick off my boots, for I thought from the shock that we must founder, and was determined to make as good a fight of it as possible. A glance round showed that the starboard bulwarks had been swept away from about 'midships, and with them boats and a deckhouse, while the starboard

Fig. 3



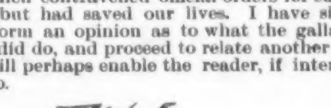
stays of the smokestack had disappeared and the main and mizzen shrouds and backstays swung in against the masts. Some minutes passed before I was able to get a word with one of the junior officers, when I learned that the ship had not received any serious damage, and that the injuries she had sustained were all above board. "What was it that struck us?" I asked. "A large, square-rigged vessel. She bore down straight upon us, under as much sail as she could carry. The beggar carried no lights, but just as we struck I saw a fellow jump into the bows with a lantern." After I had with some difficulty recovered my discarded boots in the darkness, I walked aft on to the

Fig. 4



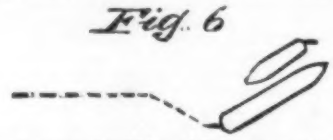
quarter-deck, and found the captain near the wheel. "A pretty close shave that, Captain S——," I said. "Yes," he answered, quietly and seriously; "*but if I had followed the sailing instructions, we should not be here now to talk about it.*" It was not my province to ask him to explain, but I felt that at a critical moment his thorough seamanship had inspired him to do something which contravened official orders for such emergencies, but had saved our lives. I have since been able to form an opinion as to what the gallant little captain did do, and proceed to relate another incident which will perhaps enable the reader, if interested, to do so too.

Fig. 5



Several years after the adventure narrated above, I was standing on the pier at Halifax, seeing off some friends on the Cunarder Alpha. As the steamer shot out into the stream, a friend who stood near me (a shipowner himself, much interested in matters of navigation, and a keen observer) remarked: "G——, what course will that steamer take when her helm is just a-port?" I answered, "Why, surely, there can be no doubt about it; her head will come round in the other direction." "No, it will not," he said; "her course will be very soon changed to that direction, but you will find that it is the stern of the vessel which will be deflected to the left, and not the bow which moves round in the direction you suppose. Now take a line along that ship to the white house on the opposite shore, and note the movement." I did so, and surrendered my opinion at once, for he was right. The following diagrams will illustrate my observation: Fig. 1 is the line which I was confident the ship would follow; Fig. 2 suggests the deflection which I actually saw.

Fig. 6



Now my preconceived idea of the movement of a vessel when the helm is put up or down is, so far as my observation goes, the universal belief. If this is so, what a fruitful source of collisions! In the hope of eliciting a description which may throw light upon this important matter, and lead to beneficial results, I have written this article.

Some ten years ago (if my memory serves) occurred the disastrous collision between the two German ironclads Grosser Kurfurst and the Konig Wilhelm. The facts of this catastrophe prove, as it seems to me, the principle above stated and the ignorance of the commanding officers in regard to it. The two vessels in question had in the course of maneuvering got into dangerous proximity, while steaming parallel to each other, and orders were given to sheer off and separate, the belief being that if one helm were put down and the other up, the vessels would diverge in regular curves. What actually occurred was that the sterns of the two vessels approached each other until the collision occurred, which resulted in the sinking of the weaker vessel and the drowning of the greater part of the crew. In the inquiry which was made into the cause of this disaster, the officers of both ships were pronounced free of blame, and it was determined to institute a course of experiments to ascertain how the vessels could have come into contact while efforts were being made to separate them. I have never heard what the result of the experiments was, and do not think that it was published.

To illustrate by a diagram, Fig. 3 represents the intended course of the two ships while separating, Fig. 4 their actual course.

Not long after the preceding catastrophe, occurred the following collision, which must be well remembered. Two Sound steamers of the same line, the Stonington and Narragansett, were proceeding to their destinations. They had been accustomed to pass each other midway of the route for years, but on this occasion they proved to be approaching each other too directly. The rule of the road was followed on this occasion. Each vessel obeyed the sailing instructions, as was afterward admitted. If these were adapted to such cases, they ought to have cleared each other. But they were approaching head on with great speed, there was not sufficient interval to allow further stern deflection, and they were brought into collision with such violence that one sank with the loss of many lives. The newspapers commented on this collision as inexplicable because the sunken steamer was struck on the reverse side to what would have been expected, which fact is easily explained upon my hypothesis. It was, I believe, by ordering the helm of the Merlin in a sense directly opposed to the published instructions that Captain S. so deflected the after part of his ship in the few moments allowed to him as to receive a glancing instead of a direct blow.

As a last illustration, I will instance the loss of the fine steamer Oregon. The facts in this case are, unfortunately, not very clearly known, but it is generally admitted that she was sunk by a vessel approaching her obliquely from the port side, which, in the fog, had got too near to be avoided. It seems to me possible that the collision was owing again to the following of sailing directions based upon ignorance of the principle which I am seeking to establish. Fig. 5 shows my idea of what actually happened, Fig. 6 what might have happened if the instructions had been directly disobeyed.

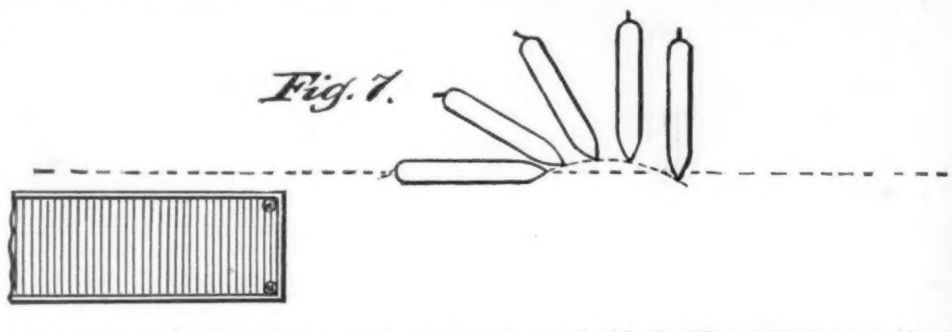
Had the vessels then struck, it would have been a glancing blow, which would not have seriously injured the steamer.

It is to be hoped that a series of experiments as to the amount of this deflection, and its relation to the length, draught, and speed of the vessel, might result (if it is not presumptuous in a landsman to say so) in such a modification of the sailing instructions for such critical cases as I have above instanced as may avert collisions arising from similar causes in the future.

Since a conversation on this subject here, incited by the accounts of two very recent collisions of English ironclads, a friend informs me that he has observed a steamboat leaving a wharf in Toronto Bay which he carefully lined by means of a stationary object on the island opposite. The boat was steaming directly away from him at five or six knots, when the helm was ported, and he saw that *the whole vessel* was deflected to the left side of the line on which she had been traveling, and that it was some seconds after the helm was ported before her bow crossed that line. See Fig. 7.

Toronto, Canada.

Fig. 7.



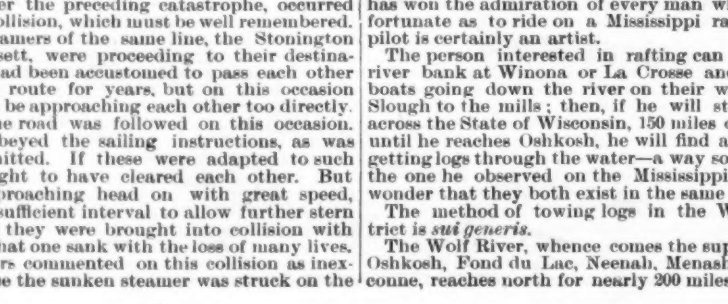
A NOVEL RAFT BOAT.

THE methods of handling logs are no more universal than are the rules of inspection. Probably the Mississippi River operators would say that they had reached the highest known stage of perfection in the rafting line, and when looked at as an art, anybody acquainted with the different processes would agree with them. The reckless, dare-devil disposition that was required in earlier days in getting rafts down the Wisconsin or the Susquehanna is not called for on the Father of Waters, but instead there is brought into service what would rank at a species of engineering skill. The raftsmen on the Mississippi would think it as unworkmanlike to pull a raft through the water as a high-bred sportsman would to shoot a bird except when on the wing or to catch trout with angle worms. To shove a great mass of logs down the river, forcing them into the proper channels and avoiding the dangerous projections and bars, is an accomplishment which has won the admiration of every man who has been so fortunate as to ride on a Mississippi raft boat. The pilot is certainly an artist.

The person interested in rafting can stand on the river bank at Winona or La Crosse and see the raft boats going down the river on their way from Beef Slough to the mills; then, if he will strike eastward across the State of Wisconsin, 150 miles or thereabout, until he reaches Oshkosh, he will find another way of getting logs through the water—a way so different from the one he observed on the Mississippi that he will wonder that they both exist in the same country.

The method of towing logs in the Wolf River district is *sui generis*.

The Wolf River, whence comes the supply of logs for Oshkosh, Fond du Lac, Neenah, Menasha, and Winneconne, reaches north for nearly 200 miles, and upon its banks and those of its numerous tributaries are yearly cut about 100,000,000 feet of logs for the above markets —largely pine, with small amounts of hemlock and hard woods. About 20 miles north of Oshkosh, the river widens into a shallow lake, named Povgan, at the southern outlet of which is the town of Winneconne; thence south a few miles of river, and another lake, Buttes des Morts; thence three miles of river, upon



A RAFT BOAT.

whose banks stands the city of Oshkosh, whose eastern line is that of Lake Winnebago, said to be the largest body of fresh water in the United States wholly within the limits of one State. Where the river debouches into Lake Poygan are the rafting grounds under control of the Wolf River Boom Company. At these grounds the rafts, made into what are called fleets, are taken possession of by the queer-looking raft boats. These boats are small sidewheelers of very light draught and engines of moderate power. Near the bow of the boat stands a large oak pole, 40 feet long, called a growser, and weighing two and one half to three tons. This is pointed with iron, has an iron band on one side, and slides downward through an iron-lined aperture in the bottom of the boat. It is held in its position by a clamp. The purpose of the growser is to anchor the boat.

Behind the wheel house is a strong oak beam, known as the tow or paddling post. To this the tow line is attached for towing rafts, where there is a current, but when the lakes are reached, or when the wind is unfavorable, growsing is resorted to.

On the lower deck there is a large wooden barrel, or spool, around which is wound 1,200 feet of the best Manila rope, from one and three fourths to two inches in diameter. This is connected with the engine by a sleeve clutch working on a feather key. The rope is attached to the fleet, and the boat runs ahead till the rope is out, when the clamp is unloosed and the growser drops into the mud, firmly anchoring the boat. The spool connection is then made, and the fleet pulled up to the boat, and then up growser and away again; and thus alternately running ahead, dropping growser, and pulling up, the lakes are passed, and the fleet moves along at the rate of two miles an hour. Arriving at Oshkosh, the rafts are uncoupled and delivered to the bull pens or hitching grounds of their owners.

Even the uninitiated can see the points in these boats which endear them to the Wolf River lumbermen. They can be run in very shallow water, and when the growser is down—when the boat, as it were, digs its toe nails into the bottom of the lake to get a firmer foothold—the power exerted on the rafts represents that which would otherwise have to be produced by a more powerful and consequently more expensive craft.—*N. W. Lumberman.*

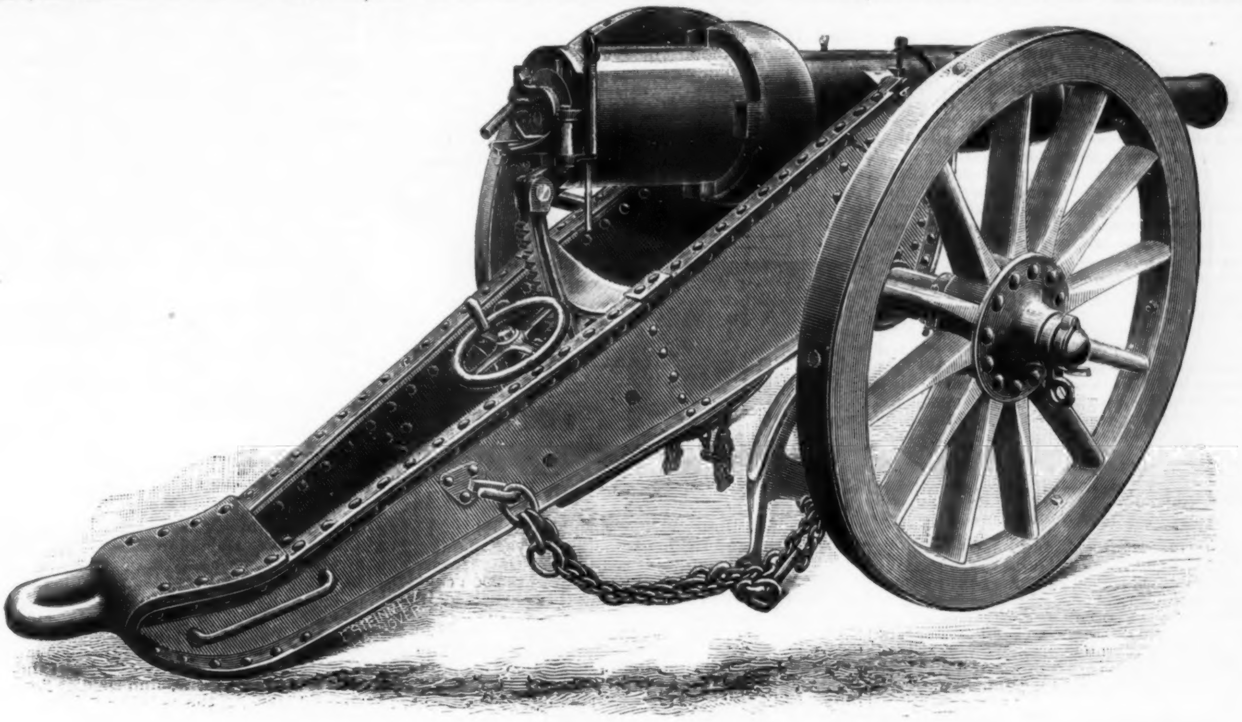


FIG. 1.—TWENTY-FIVE POUNDER ELEPHANT GUN.

RAPID FIRE GUNS AT THE NEWCASTLE EXHIBITION.

FIG 1 shows a 4 in. jointed (25-pounder) elephant breech-loading gun designed for field and siege service and for transport by elephants. One of its special features is that it can be divided into three parts, each of which weighs 893 lb., and forms a load for an elephant; this arrangement gives great facility for carriage. It appears to be a valuable as well as novel weapon, and considering that our empire is the only power which possesses trained elephants, it should prove without a rival for the special work for which it is intended.

The original 6-pounder rapid fire gun was intended for use either on board ship or from a boat, and the conditions were that it should be able to fire twelve rounds a minute, the gun being destined chiefly for use against torpedo boat attack.

Of late, an extension of the use of metallic cartridge cases, and simultaneous loading, has been carried out to guns of considerable shell power and penetration, thereby largely increasing the area which can be effectively defended by guns of this class.

It is obvious that if a considerably increased rate of fire can be obtained from a weapon firing a 30 lb. or even heavier projectile, a great addition has been made to the value of the smaller caliber guns on board ship, whether for defense against torpedo attack or for other purposes.

This is the object Sir W. G. Armstrong, Mitchell & Co. have had in view in designing the heavy caliber rapid fire gun, as illustrated in Fig. 2.

The 30-pounder rapid fire breech-loading gun, caliber 4·724 in., or 12 centimeters, fires a shell of 30 lb., with 9 lb. of powder. The gun is composed entirely of steel; its total length 14 ft. 2⅝ in., length of bore 35 calibers, and weight 34 cwt.

The breech is closed, like other Elswick breech-loading guns, on the interrupted screw system, but the novelty consists in making the breech screw conical in form, and forming the screw threads in steps. The conical form not only permits of more rapid working, as, by its adoption, one motion in both opening and closing the breech is dispensed with, but the resistance

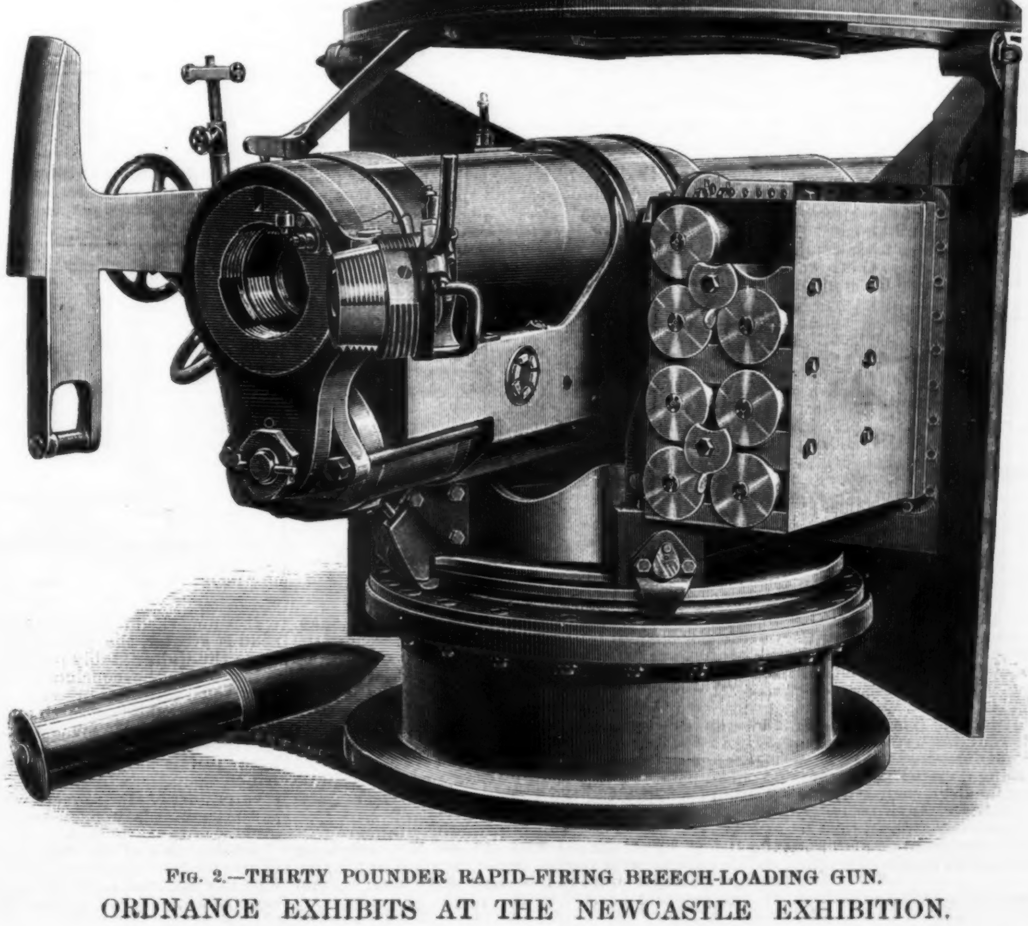


FIG. 2.—THIRTY POUNDER RAPID-FIRING BREECH-LOADING GUN.

ORDNANCE EXHIBITS AT THE NEWCASTLE EXHIBITION.

of the whole thickness of the breech piece is brought into play in opposing the longitudinal strain. Again, by arranging the thread in sections, and placing the sections on one step opposite the blank spaces on the other, the resistance of the whole circumference of the breech piece is utilized. The gun is fired by electricity, the mechanism for that purpose being simple and ingenious. In the base of the cartridge case is screwed an electric primer, against which a brass pin, carried in the axis of the breech block, presses. This pin is in communication with the electric wires, which carry the current to fire the primer, only when the breech block is closed, and secured by turning the lever downward, against the rear of the block. In this manner all danger of accidental discharge is avoided.

The Vavasseur mounting consists of an under carriage, or slide, carried on four rollers, and working round a central pivot. To the front is attached a shield, to protect the gunners. The training is effected by means of a pinion on the left of the carriage, working in a rack on the bedplate, and the elevating by a rack, pinion, and worm, also on the left of the carriage. The shafts which actuate the training and elevating gear are both brought well to the rear, and close to the wooden shoulder piece, against which the fireman aiming leans, so that he has everything close to his hand. The carriage proper works on top of the slide, the recoil being checked by means of an hydraulic buffer. The running out is automatic after each round.

This gun has been most successfully tried at the government ranges, a rate of fire of ten rounds per minute having been obtained.

A 70-pounder rapid fire gun is nearly completed, in which, in the main, the arrangements adopted for the improved 30-pounder have been followed. Should this gun give good results, it is possible that rapid firing guns will replace on board ship all the lighter artillery, whether forming the main armament of small vessels or the auxiliary armament of large ironclads.—*Engineering.*

NEW EXPERIMENTS UPON THE THRUST OF SAND.

MR. SIEGLER, government engineer, has just published, in the *Annales des Ponts et Chaussées*, a memoir in which he makes known a new experimental method of studying the reactions that occur between a mass of earth and the walls that support it, and gives an account of some experiments made with such method, in order to elucidate various questions of principle, still obscure, in the theory of the thrust of earth. As these questions are of interest, we give a summary of the article.

Criticism on Old Experiments.—The experimenters who have endeavored to determine the thrust of a mass of sand upon a wall have all operated in nearly the same way: A panel of wood, movable around an axis, performs the role of a sustaining wall, and tends to pivot around the axis under the influence of a thrust. The moment of this force is balanced by that of another measurable force. In most cases, a lever fixed to the panel carries a scale pan containing marked weights that are progressively diminished until the panel swings. It is admitted that the moment of these weights with respect to the fixed axis is then equal to that of the thrust. In Mr. Darwin's experiments, a dynamometer was interposed between the panel and the counterpoises.

Method of the Four Axes.—Upon operating successively with four parallel axes placed at the upper part of a wall, the point of application of the thrust has been found a little above a third of the height. On the contrary, with four axes placed at the lower part, the point of application has been found a little below this third. The fact has been verified that the direction of the thrust makes with the surface of the wall an angle nearly equal to the angle of friction of sand upon sand.

To all these experiments the same objection may be made: Before swinging, the panel makes slight movements around the stationary axis. If this axis is fixed at the lower part, the panel disengages itself from the mass at the top; and if the axis is above, the panel disengages itself at the bottom. In both cases, the reactions are rapidly modified under the influence of the slight movements of the panel, and the experiment gives but an imperfect approximation of the thrust. We are notably unable thus to determine the component of the thrust situated in the plane of the interior surface: that is to say, the tangential component. If the axis is in this same plane, the component has a null moment; and if it is outside of this plane, there develop, between the panel that is beginning to pivot

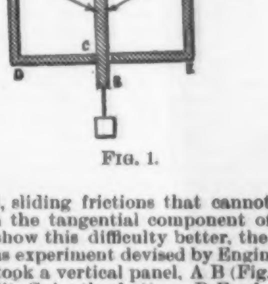


FIG. 1.

and the sand, sliding frictions that cannot be distinguished from the tangential component of the static thrust. To show this difficulty better, the author recalls a curious experiment devised by Engineer in Chief Gobin, who took a vertical panel, A B (Fig. 1), passing through a slit, C, in the bottom, D E, of a box, and suspended by a cord from a pulley. The box being filled with sand, if the thrusts that the two surfaces of the panel experience are oblique to such surfaces, they ought to give a vertical resultant directed downward. In order to determine whether in effect such a resultant exists, Mr. Gobin measured the stresses necessary to displace the panel in its plane, either downward or upward. He found that such stresses are equal, and concluded therefrom that the vertical resultant sought is null.

This conclusion does not seem to be well founded. A downward thrust on the panel cannot exist and be measured unless the panel is capable of resisting this force; that is to say, unless it is kept in place. If the panel gives way, it diminishes and then becomes annulled. If the panel is drawn downward, the reaction that it undergoes on the part of the sand changes direction. What Mr. Gobin measured was the sliding friction of the panel on the sand, in its downward and upward motion; he ought necessarily, then, to have found the same resistance in both directions.

In order to solve problems of this kind, the panels supporting the thrust must remain entirely immovable, and we must succeed nevertheless in measuring the reactions that they undergo on the part of the mass.

Use of Violin Strings.—In order to overcome this difficulty, Mr. Siegler first tried a very imperfect but interesting method. As dynamometers, he used taut violin strings, and repeated, among other experiments, that of Gobin described above, in suspending the panel between two short violin strings attached to each extremity at fixed points. After determining the notes given by the cords when the box was empty, sand was slowly poured in in horizontal layers by means of a

FIG. 2.

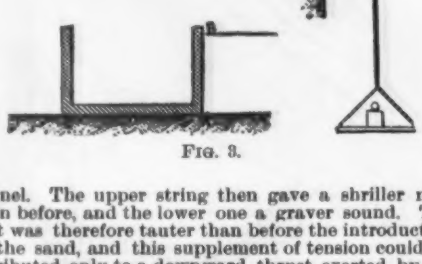


FIG. 3.

funnel. The upper string then gave a shriller note than before, and the lower one a graver sound. The first was therefore tauter than before the introduction of the sand, and this supplement of tension could be attributed only to a downward thrust exerted by the sand upon the panel.

But it is clear that the panel had not remained immovable, and had been carried along slightly by the sand, and that this method responds but incompletely to the conditions laid down. It shows that there is a tangential thrust, but does not permit of measuring it.

Use of Electricity.—An endeavor was afterward made to apply to the problem the well-known property that carbon possesses of becoming a better conductor of electricity when it undergoes an increasing pressure. Two superposed carbon disks received the pressure that it was desired to measure, and formed part of a circuit comprising a pile and a galvanometer of feeble resistance. Upon increasing the pressure, the intensity of the current kept increasing.

It was thus possible to graduate the apparatus empirically, and afterward place the disks under Mr. Gobin's panel to measure the intensity of the current before and after the introduction of sand, and to deduce the thrust of the latter. It is clear that the compression of the carbon disks could be considered of little consequence, and the displacement of the panel as null. Unfortunately, this method could not be rendered practical.

Friction Dynamometer.—In order to determine the intensity of a pressure without displacing its point of application, Mr. Siegler measures the sliding friction that such pressure develops with a small friction dynamometer (Fig. 2).

A strip of iron, A, is placed between two plates of iron, B and C, which are provided with grooves in which A can slide. The plate, C, is screwed to a fixed support. It is provided with two pins, *m*, which enter corresponding holes in the plate, B, and prevent the latter from moving horizontally. The pressure to be measured is exerted perpendicularly upon the plate, B, and consequently upon A and C. To the plate, A, is fixed a cord, I, that passes over a pulley and carries a scale pan.

Neglecting the weight of the strip and upper plate, the sliding friction that must be overcome by means of the scale pan is proportional to the pressure. Nothing is easier than to tare the apparatus, by placing loads upon the upper plate of 1, 2, and 3 pounds, for example, and noting the weight that must be put into the pan

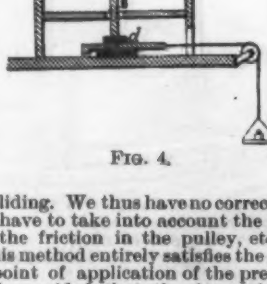


FIG. 4.

to cause a sliding. We thus have no correction to make, and do not have to take into account the weight of the apparatus, the friction in the pulley, etc. It will be seen that this method entirely satisfies the desideratum, since the point of application of the pressure is absolutely fixed, provided that the faces of the movable strips are exactly parallel. However, it is not entirely accurate, since, despite every possible precaution, errors amounting to from 8 to 10 per cent. cannot be avoided. We might probably attain a greater approximation by improving the construction of the apparatus.

Experiments.—The following experiments prove that the thrust upon the internal surface of a sustaining wall is oblique with respect to such surface, and makes with it an angle equal to the angle of friction; so that to the pressure exerted by the weight of a sustaining wall upon its foundation is added the tangential component of the thrust, which increases the pressure upon the foundation ground just so much. This explains why an empty box (Fig. 3) is capable, through the surface, AB, of sustaining a mass of sand.

1. *Mr. Gobin's Experiment modified.*—Under the vertical plate, A B (Fig. 4), is placed a friction dynamometer, *d*. In order to prevent the plate from falling when the box is empty, it is held by two flexible cords, *m n*, *p q*, that are fixed at *m* and *q* to the sides of the box, and that can give no vertical reaction. A determination is made of the weight necessary to put in the scale pan to cause the movable strip of the dynamometer to slide when the box is empty. The box is carefully filled with dry sand, and the weights necessary to produce the sliding are again put into the pan. It is found that such weight is greater than it was before the introduction of the sand. With a box 9½ inches in length and 8 inches in width, and with a height of sand of 4⅜ inches, we thus find that the dynamometer receives from the sand a vertical thrust of 22 ounces.

2. *Thrust upon a Sustaining Wall.*—This experiment was performed with a box open on one side. To understand the arrangement, we may suppose that the part to the right of the panel in Fig. 5 is suppressed. The horizontal shifting of this panel is prevented by means of four horizontal cords fixed to pins driven into the sides of the box. These cords cannot cause any vertical reaction, and consequently cannot vitiate the experiment.

The dynamometer is tared, and the box is filled with sand. The friction developed in the dynamometer is measured anew, and the vertical pressure that it receives from the panel is deduced from it.

In operating with a box 12 inches square, and with successive heights of sand of 4, 8, and 12 inches, we find the following figures:

Height of sand.	Vertical component of the thrust.
4 in.	0·66 lb.
8 "	1·76 "
12 "	1·76 "

These figures demonstrate in an absolute manner that the vertical component of the thrust exists; but it would be necessary to operate upon a larger scale to obtain numerical results utilizable for the theory.

The sand had a density of 1·6, and a natural slope of about 33° with the horizon. On ramming it down in horizontal layers, we find vertical components that are sensibly feebler. So, too, when we make measurements successively for heights of 8 and 4 inches in gradually emptying the box, we find smaller figures for the same height than in the period of filling. This difference will be explained further along.

3. *Distribution of the Weight of Sand over the Bottom and Sides of a Box.*—Finally, it has been determined how the weight of a mass of sand placed in a box is distributed between the bottom and sides.

A bottomless box (Fig. 5), 10 inches in length, 6 in width, and 15 in height, rests on the one hand, through a knife edge, C, upon a stationary table, and on the other, at E, upon a dynamometer, *d'*, fixed upon the same table. The weight of this box and the vertical stresses that it will undergo will be distributed equally between the knife edge, C, and the dynamometer, *d'*, which are placed symmetrically with respect to the axis of the box. It will suffice, then, in order to have the total of these stresses, to double the pressure measured at the dynamometer and to deduct the weight of the box.

A bottom, I K, independent of the box, rests upon another dynamometer, *d*. The taring having been effected, two layers, of 17½ lb. each, of sand are put into the box and leveled off.

The following pressures are found:

Weight of sand.	Height of layer.	Vertical pressure on the sides.	Vertical pressure on the bottom.	Total.
17½ lb.	7 in.	9·6 lb.	8·8 lb.	18·4 lb.
35 "	14 "	22 "	12·76 "	34·76 "

The difference between the weight of the sand and the sum of the pressures is due to experimental errors. It does not exceed 5 per cent.

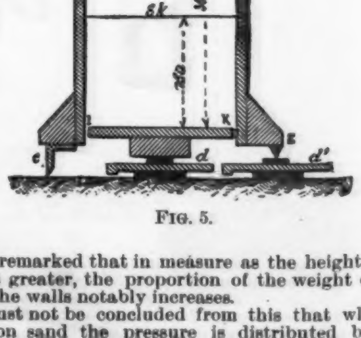


FIG. 5.

It is remarked that in measure as the height of the sand is greater, the proportion of the weight exerted upon the walls notably increases.

It must not be concluded from this that when we build on sand the pressure is distributed between the lower foundation earth and the lateral walls in the above proportion. All depends, in fact, on the respective resistance of the strata of earth met with. If the lower soil is hard and surmounted by compressible strata, the latter will yield in a vertical direction, and a greater part of the pressure will bear upon the bottom. If the ground is homogeneous, the walls will take the greater part of the load.

Explanation of the Facts observed.—The existence of the tangential component is placed beyond a doubt. The two elements upon which this component depends are (1) the coefficient of the friction of the sand upon

itself and upon the internal surface of the wall and (2) the compressibility of the sand. If the friction were null, it is clear that there could be no vertical component. But that does not suffice.

Were the prism of the greatest thrust incompressible, it would bear by its lower point, like a rigid body, upon the basal plane. Its entire weight would be transmitted to the base, and the pressure that it would exert upon the wall would be merely horizontal. But such is not the case; sand is compressible, and has a tendency to pack. If we pour sand into a box (Fig. 6) having a vertical glass side, and now and then interpose a thin stratum of sand of a different color, we observe a subsidence gradually taking place, but not in horizontal strata. The sides exert a retarding action upon the settling, just as do the sides of a water conduit upon the liquid that flows through it. This retarding action necessarily supposes a vertical reaction downward of the sand upon the wall. It is the tangential component of the thrust. And this force develops as long as the sand has a tendency to settle, that is to say, as long as the limit of compression is not reached.

We now understand why, in experiment No. 2, we found feebler vertical components, with the same height of sand, in the period of emptying than in that of filling. The lower stratum of sand, at first compressed, expanded, so to speak, and reacted upon the sides from bottom to top instead of lying heavy on it.

It will be remarked, too, that the elementary vertical component of the thrust furnished by a horizontal section of the mass does not depend solely upon the normal pressure, but also upon the degree of subsidence of the lower strata. This component is analogous to the sliding friction, but it does not vary in the same way as that upon the height of the wall. In the section in contact with the earth the vertical component is sensibly null, while the sliding friction, proportional to the normal pressure, is maximum.

The sliding friction develops when the wall displaces itself or tends to do so. The tangential component exists in the absence of all motion.

A conclusive experiment shows that the pressure of an embankment upon its base is diminished of all the weight that bears upon the surface of the wall. The part of the mass near the wall remains suspended there, so to speak, and bears less upon the ground. If we could determine the lines of equal vertical pressure in the interior of the embankment, we should find curves analogous to those shown in Fig. 7.

In measure as subsidence proceeds, these curves approach horizontality.

As the existence of the vertical component contributes to the stability of the wall, it will be seen that subsidence would diminish such stability if it did not at the same time contribute to reduce the horizontal thrust and increase the cohesion.

Conclusions.—The friction dynamometer permits of

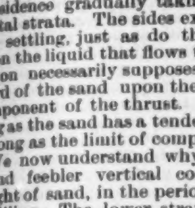


FIG. 6.

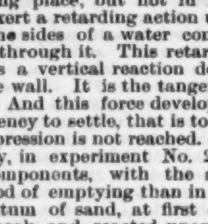


FIG. 7.

measuring forces without shifting their point of application, and may, for this reason, find applications in various experiments on the resistance of materials. With this apparatus it is possible to eliminate the causes of error that a large number of experiments on the thrust of earth admits of. It has been found possible, especially, to make evident and to measure the component of the thrust exerted on the inner surface of a wall sustaining a mass of sand. This component is distinct from the friction that occurs between the sand and the wall when the latter begins to displace itself. It exists in a state of rest in consequence of the sand's tendency to subside, and it increases the pressure that the wall exerts upon its foundation.

Laboratory experiments, performed necessarily upon a small scale, could not furnish coefficients applicable to constructions and to the calculation of the thickness of sustaining walls. Dry sand, moreover, is a body of a very peculiar nature, which, especially under heavy pressure, behaves very differently from earth, and especially from clay.

METHOD OF MAKING A CABLE.

WHIZ-Z-Z—bur-r-r—clatter-r-r—buz-z-z! These were the only distinguishable sounds that greeted the *Western Electrician* representative as he was ushered into the insulating room of the Western Electric Company, Chicago, bound on seeing a telephone cable pass through all the processes of manufacture from the bare copper wire to the reel on which a huge cable had been shipped away as he entered the factory. Amid the clatter of this insulating room it is well-nigh useless to attempt to listen to explanations, and the eyes must convey the information to the brain. We will watch the process of making what is known to the trade as a twenty-five wire cable. The naked copper wire is brought on a reel to a winding machine. This is the machine that prevents the questions that would otherwise be asked—not that any one machine is particularly noisy, but one machine in conjunction with a hundred others succeeds in creating a second Babel. In an adjoining room are the braiding machines, which serve the same purpose as the winding machines, differing, however, in the character of the work they turn out. In the case of the winding machines the covering of cotton or jute is wound round the wire, and in the case of the braiding machines the covering is braided about a wire as a core. To those unaccustomed to a braider the sight is a novel one. The parts of the machine carrying the thread follow such serpentine courses, flash in and out, double on their own courses, and engage in such convolutions that the uninitiated stranger awaits with abated breath the moment when the machine will twist itself into such knots that there will be a general smashing on all sides. The catastrophe does not occur. Now and then a thread breaks; the girl in charge, who has been coolly eying the stranger, calmly halts the crazily whirling machine, as calmly reunites the ends of the thread and starts the machine in its whirligig course again. But it is through the winding machines that the bare copper wire passes until from one end to the other it is covered with its cotton or jute dress. As fast as it is dressed, so to speak, it is wound on a reel to await the next step in the process. Twenty-five of these wires are covered or insulated, as the technical term is, and then the whole twenty-five are bound together and covered in the same way as the first wire. At the conclusion of this step in the manufacture, the cable, for that name can be given it now, resembles a rope. The

FIG. 1.

cable then goes to another part of the building, where it enters a huge oven and is thoroughly dried in order to get rid of that bane of a good cable—moisture. After an exposure of about twelve hours to a heat of about 180 degrees Fahrenheit, the cable is ready for its bath of paraffine, the purpose of which is to exclude any moisture that might tend to work back into the cable at any spot. Into a large iron tank partially filled with melted paraffine, which, so far as appearance goes, resembles water, the cable is placed, and it receives a thorough soaking. When the melted paraffine has penetrated every pore of the cable, the latter is replaced in the oven for another hot-air bath, but the ends of the cable are brought through perforations in the side of the oven, for a purpose to be explained, leaving the coil on trucks on the oven floor. This cable, may be several thousand feet long, is to be drawn through a

FIG. 2.

lead pipe, which, by the way, is of special composition for this purpose. The lead pipe is made in lengths of 125 feet or more, and the casual visitor may puzzle his brain some time before arriving at the method by which that cable is to be drawn through that pipe. The lengths of pipe are laid side by side on the floor of the room in which these operations are carried on. The ends of the pipe are not soldered together, and up to this point we have a continuous cable and a number of pieces of lead pipe whose aggregate length is the same as that of the cable. The next step in the process is an exceedingly simple one, and yet leads the way to the solution of what looked like a complex problem. One of the employes takes a wad of cotton and attaches to it a fine, light, but strong string, which in turn is connected with a rope, and that in its turn to one end of the cable which is still in the oven. The wad of cotton is inserted in the end of one of the lengths of pipe, a small air pump is attached to the other end, a handle is worked, and as the air in front of the cotton is exhausted, the atmospheric pressure behind forces it through the pipe in a flash—or to be less technical, the cotton with its string attached is "sucked" through the pipe. The rope is drawn through the pipe, and after it follows the cable. While the rope is going through the first length, the cotton and string are put through the second length of pipe, and by the time the cable is on its way through the first length, the cotton and string are in the third length of pipe, and the rope started on the second length. When the cable is through the first length of pipe, it follows the rope and thread all the way through the other lengths. The joints in the pipe are then soldered, making the pipe with its core of cable continuous for the desired length.

Again another paraffine bath. But this time the melted paraffine is forced into the pipe, under a carbonic acid gas pressure of from 80 pounds to 140 pounds. The cable is once more treated to a hot air bath, and is then wound on a reel and tested, and the wires at either end are so marked with tags as to be readily identified.

These cables are used aerially or underground or for submarine purposes. When one of these cables is used aerially, it is with the idea of carrying a number of wires within a small compass, thus doing away with obstruction to light, and not overloading the poles that support the wires. Aerial cables are generally swung from a wire that carries the cable and saves the latter from pulling apart from its own weight. Underground cables are designed to get rid of the annoyance of wires strung on poles, while submarine cables are used for crossing bodies of water where wires strung above the surface would be inadmissible. Submarine cables are sometimes armored, that is, wrapped with a heavy wire to secure immunity from damage by chafing on rocks or having anchors of vessels dragged across them.

The illustrations herewith serve to give a clearer idea of the subject matter. The group of cuts showing the cross sections of cables exhibit the different kinds of cables manufactured at the establishment visited. Fig. 3 shows an aerial cable with its insulation of paraffine and the sheath of lead pipe. Fig. 4 differs from Fig. 3 in its armor of wire to protect it from injury. Fig. 5 is another form of aerial telephone cable with an induction wire through the center. Fig. 6

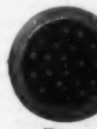


FIG. 3.

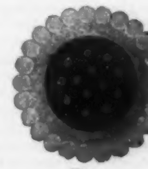


FIG. 4.

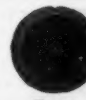


FIG. 5.

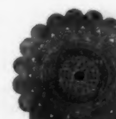


FIG. 6.

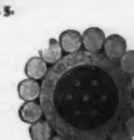


FIG. 7.

shows the induction wire, the copper conducting wires, the insulation of cotton or jute, the paraffine insulation, the sheath of lead pipe, and finally the armor of wire. Fig. 7 shows a telegraph cable which is used under water or under ground, and also shows the characteristics of other cables already described, of the paraffine insulation, the sheath and the armor. Fig. 2 illustrates the hanger used to support aerial telephone cables, while Fig. 1 shows the terminal to a cable.

A LARGE SIPHON.

A SIPHON of considerable interest has recently been constructed at the large Fritzöe works, close to the town of Laurvik, Norway. This extensive establishment comprises, besides the various works, no less than about 700 square kilometers of landed property, mostly forest, annually yielding some 400,000 pieces of timber. The large iron works were here, as almost everywhere in Norway, discontinued about a quarter of a century ago, but at Fritzöe, at least, other industries have worthily taken their place.

The present Fritzöe works consist of engineering works, two planing mills, two saw mills, two flour mills, with a yearly production of 100,000 hectoliters of flour, and a wood pulp manufactory that produces some 7,000 tons a year. The whole of this large concern is lighted by electricity. There are 240 incandescent lamps and two dynamos, driven by a separate turbine. The number of men at the works themselves is about 600.

With the exception of the two planing mills and one of the saw mills, all are worked by water power from the waterfall between the Farris lake and the town. The power amounts to 2,000 horse power, and the turbines number sixteen. The height of fall actually utilized is 36 ft., and the quantity of water required is 15·5 cubic meters (550 cubic feet) per second. The Farris lake, which forms a reservoir for the water power, has an area of 21·80 square kilometers, and receives its supply from a river of the same name. The lake water is collected and regulated by a dam dating from the year 1765. It is built of hewn stones with sluices both for the floating of timber and for the exit of the water. The dam does not rest directly on the rock, but has its foundation on clay and gravel.

Taking the large quantity of water into consideration, this construction is not altogether favorable, al-

though no mishaps have occurred during the 120 years the present dam has existed. As the power required at the works increased, the supply of water was not always sufficient, especially in the winter, it being impossible to draw the necessary 15·5 cubic meters per second through the sluices of the dam when the water in the Farris sank below a certain level. On the other hand, the average quantity of water in the river was sufficient to produce the above quantity all through the year. There were, consequently, two alternatives, either to raise the level of the water in the reservoir (the Farris lake) by making the dam higher, or to draw it to a greater depth. The latter course had several advantages; a higher water level might prove prejudicial to the surrounding property, and the dam might not be able to stand the greater pressure from the increased volume of water. The plan adopted for lowering the level of the water would, in most cases, have been to sink the sluices already existing or to make new ones below these. This could, however, not be done on account of the nature of the dam foundation, and the building of a double siphon was therefore decided upon. It was thought advisable to give this the full capacity of 15·5 cubic meters per second, so that the tubes could carry the entire quantity of water required, should the level of the Farris reservoir sink below the bottom of the sluices in the dam. The siphons can now draw the water to a depth of 4 ft. below the bottom of the slucies.

The diameter of the siphons is 5 ft. 2 in., and they have a length of 82 ft.; their suction height is 3 ft. 11 in., and the height of the fall is 4 ft. 8 in. The mouthpieces are of cast iron, and these, as well as the air pump, are made at Forsvik's Engineering Works, Sweden. The siphons themselves are built of riveted ¼ in. steel plates from the Motala Works, Sweden. The riveting and putting together has been done at the Fritzöe Works. The opening and the closing of the siphons is done by a ring sluice, which is lifted vertically by hand power by the aid of a screw gear; only one man is required to do this. The air pump is situated in the middle between the two siphons, one pump acting upon them both. Four men can pump out the air of both siphons in ten minutes. The two siphons are placed side by side in one of the old sluice holes in the dam. The mouthpieces rest upon 12 in. timbers, covered with 3 in. boarding.

The fixing of the siphons was a work of extreme difficulty. It was necessary to build an intermediate semicircular embankment above the proper dam. This had a diameter of about 16 meters, and was built of poles, on the outside of which horizontal beams were fixed, and these were covered with 2½ in. boarding. Outside these there was a layer of gravel, etc., of about 5 ft. thickness. The water was pumped out of the outside by two 12 in. pumps, worked by a 6 horse power portable engine. While this was going on the water was taken through an aperture at one side of the dam and led down to the Fritzöe works through a provisional canal. At last it however became necessary to close the reservoir altogether for some weeks. The cost of the siphons amounted to about 40,000 kroner, and they have given great satisfaction. Another work recently completed at Fritzöe is the rebuilding of the various canals leading the water to the different parts of the works. This necessitated the laying of some 64,000 cubic feet of foundation. The length of the canals amounts to 1,600 ft. The pulling down of the old and building of the new ones was done in the course of four weeks, with a staff varying from 100 to 300 men. —*Engineering.*

DECORATIVE GLASS.*

By JOHN HUNGERFORD POLLEN.

THE remarks I have the honor to lay before you, ladies and gentlemen, this evening, are descriptive of a beautiful and fairy-like art. I call it fairy-like, not only because of the delicacy and beauty of the material used, but because of the simplicity of its manipulation and the rapidity with which its most attractive creations are effected.

Glass is transparent as water, and, like the drops and jets of water, threads of it are crystallized into jeweled forms by the action of the air; and, again, light, brittle, and destructible as glass vessels are, they are yet capable of outlasting many, if not most, of the substances out of which vessels can be made for our use.

1. Before proceeding to discuss the manipulation of our material it will be necessary to show how it is made. Glass, says the late Professor Barff,† appears to be a mixture of silicates. The material is principally sand, with an alkaline substance, either a salt of soda or potash and lime; though in some kinds of glass oxide of lead takes the place of lime.

The scientific name for sand, or, rather, its principal constituent, is silica. This compound oxide of silicon, or silicic acid, when brought into contact with bodies of an opposite character, under suitable conditions unites with them and forms a salt. Now, silicic acid, at the ordinary temperature of the air, has no action whatever on carbonate of soda, but when heated sufficiently, the action becomes vigorous. When sand is mixed with oxide of lead (common litharge), they unite, forming a compound similar to that produced by the silica united with the soda. In one case a soda glass is formed, in the other a lead glass; the former is made with coarser or finer sand, according to what is to be made from it, such as common bottles, crown, sheet, or plate glass. The latter kind is called flint glass, and is used for the finer works of the glass blower—glasses, table decanters and glasses, and imitation jewels. It is more brilliant, colorless and transparent; it is also considerably heavier than window glass.

2. In putting together the materials for glass making of the finer kind, it is of great importance that the sand should be as free as possible from impurities. The Venetian furnaces are said to have been supplied from the coast of Syria, where the sand had been famed for its excellence from the days of ancient Rome. The sand now used for flint glass is brought from Alum Bay, in the Isle of Wight, and from Fontainebleau, in the latter case at high prices. The principal impurity found in common sand is some form of oxide of iron, which produces a green color, and the presence of iron is neutralized by adding black oxide of manganese. This reduces the oxide to the state of peroxide. Peroxide produces a yellow hue, and only to a slight degree. It is by no means easy to adjust the quantity of black oxide of manganese to the amount of iron in the sand, and if in excess, a purple color is produced. Much of the window glass of ninety years ago is of a purple hue on this account. If rightly proportioned to the iron in the sand, no appreciable color is imparted by this substance. I believe that at present arsenic is considered, for various reasons, an equally effective and more manageable agent for this purpose than black oxide of manganese. The proportions quoted by Professor Barff for window glass materials are: Sand, 4; sulphate of soda, 2; lime, about ½ to 1, with a small quantity of carbon as charcoal. For flint glass: Sand, 3; red lead, 2 to 2½; carbonate of potash, 1½ to 1¾, with a little niter, or saltpeter, as an oxidizing agent. The analysis of Pompeian glass gives: Sand, 4; soda, 1; lime, ½ (about); and a small quantity of alumina. Here the proportions of soda seem much less, and lead does not enter into the mixture. Different makers vary these proportions, and have mixtures of their own. If soda is in excess, there is apt to remain a certain amount of it not properly reduced, and it is gradually dissolved by the action of the weather, making those holes which we see on the outside of some old window glass. Sometimes we see on the surface a delicate film, which, seen in a certain light, is opalescent. This is also noticeable in glass that has been long buried, from the action of salts in the superincumbent earth, and shows that the due proportion of the materials has not been observed, and a perfect union has not resulted. It would be very desirable that careful experiments should be made by chemists, so as to save glass founders from errors of this kind, as far as they can be made avoidable.

The materials are partially heated together and are then called fritt. The fritt is afterward put into glass pots, made of fire clay, in the furnace, where they are gradually fused, and fresh fritt is added till the glass is in a doughy state, not too liquid, in which condition it is known as metal. The pots for window glass are uncovered, and the fire passes over them. Those for flint glass are covered over, leaving an opening in front for the use of the blower. A scum which rises to the surface is removed by iron ladles. A small quantity of broken glass is thrown in at intervals to complete the fusion and purify the metal.

3. Various colors are imparted to glass by the mixture of metallic oxides: red, by copper, as well as green and blue, according to the nature of the oxide: blue by cobalt. A beautiful pink is produced by oxide of gold, and, if used in large quantities, a fine red. Oxide of iron produces either green or yellow. Yellow, of various depths, is also produced by silver, but not by melting it with the metal. Oxide of silver is mixed with chalk, or some similar substance, and laid on the glass when cold, and it is then heated to a dull red, and the yellow stain is pale or deep, according to the quantity of oxide used. Red produced by oxide of gold and copper red are both coated over clear glass heated and blown into sheets. Purple and black are produced by black oxide of manganese. There are, however, many varieties of hue which are produced in different factories, some, probably, by accidents of the melting. It is of these materials that painted glass is made, but, as glass painting belongs rather to the painter's art, I shall not attempt any discussion of it here. As we see it in old church windows, it is the very romance of mediæval painting, and its special claims depend on the mellowness and beauty of the glass prepared for it.

4. Besides glass colored in the metal, gold leaf can be laid on glass, etched and coated over with a thin film of glass. Glasses colored, but more or less opaque, are used in small dies on walls and vaults, for another kind of painting called mosaic. Light is reflected by this kind of painting, but it is transmitted in many hues by painting on colored glass in windows. The Whitefriars furnaces turn out a peculiar kind of glass, opaque, and having the look of unglazed porcelain, on which designs are drawn and painted with enamel colors, and these paintings are put into muffles (small kilns, which can be gradually heated at will), and burnt in as in window painting. Like mosaic work, it is a kind of decoration applicable to wall surfaces, in which it can be embedded. I notice it here because this kind of glass is the result of a peculiar process. It may be produced by breaking up glass of the color required, and fusing it over again. What sort of intensity of heat, or period of time may be required in its fusion, I do not know, but it may be produced in another way. I shall have to advert presently to the process of annealing, or the very gradual cooling which glass goes through before it is fit for use. Now it seems that glass, when it leaves the furnace, takes a long time for its particles to arrange themselves. If glass vessels have not been properly annealed, they are extremely brittle; they crack easily if hot water is poured into them—more easily the thicker the glass is; the inside heats and expands before the heat has reached the outside. Thin glass is less brittle. But if thick glass has been carefully annealed, it is less liable to such accidents. If, on the other hand, glass is kept at too high a temperature in the annealing furnace, and for too long a time, it loses its transparency and becomes crystalline in texture. This process is called devitrification. A kind of porcelain was at one time made of glass in this state, and went by the name of Reaumur's porcelain. Devitrified glass, as it can stand the weather, if painted and if the incorporation of the enamel colors used upon it were thoroughly understood, might, I suppose, be used not only for internal, but for external wall decoration as well.

As far as I can learn, such a complete incorporation of enamel ornament on glass of whatever kind has not been yet arrived at, the enamel having a liability to wear off the surface, and the process is perhaps still to be examined by practical chemists. So far, then, as to the composition of the various glasses in use.

5. Next, as to its manufacture. I have compared it to the crystallization of pure water by the action of the air, for it is the breath of the workman that puts life and beauty into the lumps of soft metal that he draws out of the pot. There are several distinct operations in the decorative treatment of glass. It is blown, cast, moulded, stamped, and cut in a variety of ways when cold. The oldest and the simplest process is that of making simple bottles and window glass—which is of various qualities. This is how sheet glass, for instance, is made: The workman takes an iron blowpipe, from 5 feet to 6 feet long, and from ¾ of an inch to 2 inches in diameter, according to the weight of glass he intends to work. He dips this into the glass pot, gathers by a twisting motion a lump of doughy metal at the end of it. He then blows into it till it swells out into a pear shape. He then rolls it on a slab of marble or of smooth iron, called a *marver*, so as to keep the shape and thickness he requires. It is then swung from side to side over a pit till it has drawn itself into a length sometimes of 50 to 60 inches, and has assumed the form of a true cylinder. It is again heated in the furnace. The cool end of the tube is stopped with the finger, and the air expanding within the cylinder bursts the heated end. The workman withdraws it, and while hot rolls it round, and with an iron tool brings the burst part to the diameter of the cylinder. The other end is detached from the blowpipe by drawing a thread of hot glass round the shoulder, and after removing the hot glass, a cold tool causes it to crack all round. The cylinder is scored down its length internally with a diamond, and placed in a flattening kiln; when soft, it is opened out with wooden tools where the line has been scored; it is then flattened out on the smooth floor of the kiln. Glass so flattened is sometimes polished, and is then one kind of plate glass. Commoner crown glass is made by opening the globe blown by the workman, who then heats it again, and trundles it round till the heated sides of the globe start suddenly round into a great disk, with the thick bull's eye in the middle. These kinds of glass are annealed and cut up for window glass. Plate glass is not blown, but is either ladled or poured on an iron table, which has edges to suit the required thickness of the glass. It is then rolled with iron rollers. When cold, two plates are brought into contact with each other, and the two surfaces ground with sand and water. They are finally polished by machinery, a process formerly done by hand.

6. These may be called elementary operations. Decorative blowing, which is now to be considered, is a more intricate process, for the working of which long training and skill, readiness and confidence, are required. The workman's tools are of the simplest kind. He uses a blowpipe as described, rough tongs, scissors with short, broad blades, and compasses to gauge his work as he goes on. He has a marver to roll his metal on, and a chair, of which the arms are horizontal iron rails, on which his blowpipe, or his pontee, or solid holding rod, can be revolved by one hand, acting as a rough and ready turning lathe.

Let us see how he makes one of those elegant glasses which I shall speak of as Venetian glasses, because the Venetians made them two or three centuries ago in such endless variety, and they now form the glory of glass collectors. Here, for instance, is a decorated glass such as I have had the great pleasure of seeing made in the glass house of Messrs. Powell, in Whitefriars. Withdrawing, with the blowpipe, a small lump of not too liquid glass, the workman blows it into a bulb, and the general shape—convex or conical—is given to it. He then takes a fresh piece of glass to make the stem; sits in his chair and keeps revolving his pontee (holding rod), with glass at the end on the arms, as if in a turning lathe. By the use of his tongs he contracts it where he wishes, forming neckings and bosses. If he is working from an original which he wishes to copy, or from a drawing he has prepared, he regulates the measures of his new stem by applying his compass to the drawing and to his work. Glass cools too quickly to allow the modeling of such a stem without reheating the material from time to time. If it has considerable length, he has to keep turning it round in the furnace to avoid its drooping. It is then again brought to the chair, and the lathe action renewed, till this portion of the glass is completed.

Next, an assistant, with a pontee, armed with a dab of hot glass, sticks it to the center of the bulb, the workman detaches his end of it from his blowpipe by touching it all round with a wet iron. The pontee, with the bowl of the future glass, is reheated. The operator trims the edges with a pair of scissors, rolls it on the warmer, and shapes it out with his tongs, turning the bowl of the glass round as he does so. The bowl, or body, has then to be detached from the pontee on which it has been kept, the stem heated, and the two attached. If the glass has wings or handles of white or colored glass, a small lump of the required metal (as the fused glass is called) is brought by an assistant, the modeled glass being kept at a proper heat. The workman takes a pinch of it with his tongs, draws it out to the thinness he requires, sticks it in its position on the glass, draws it out to a thread or ribbon, forms a loop or loops in it, and brings the end down again to the bowl or stem of the vessel. He pinches this ribbon in at intervals, or thinning it out into a thread, he loops it in and out as he wishes. We see on some old glasses the wings, head, claws, and feathers of the two-headed imperial eagle of the German empire.

Many of these devices are highly complicated, and when the rapid rate at which they are necessarily executed, and the lustrous crystalline beauty of the finished vessel and its decorations, are considered, there is no violence in the comparison of this beautiful art to the action of the northern wind on the raindrops, and the tender spray of the waterfall. But while these beautiful crystallizations grow dim and disappear when we grasp them, the marvels of the glass blower's art may outlast the lives of many generations.

7. I have spoken of clear glass, whether white or colored, but glass vessels were and are still made by the Venetians, and at Whitefriars and elsewhere, in which opaque white glass is inserted, taking variously shaped filigree patterns, twisted, network, and collected into beads or balls, and similar arrangements in great variety. I shall show you presently in the lantern some examples of this from the South Kensington Museum. This white goes by the Italian name of *latticinio*, or milky. The vessels made in this material are usually striped, that is, made of bands of clear glass and of glass in which these white lines, variously twisted, are contained. How is this made?

Opaque white or enameled white glass, as it is sometimes called, is made by the addition of oxide of tin, and the metal is then drawn out into little sticks called canes, as in these specimens from Whitefriars. To make these into Venetian *latticinio* or filigree, a number of short pieces of cane are arranged at intervals round a jar, and kept, perhaps, in place by a little sand at the bottom, or accommodated to slight flutings

* A paper lately read before the Society of Arts, London.

† British Industries, Glass, etc.

inside the vase. A lump of heated glass is then held by the blower just in the middle of the vase. For some time he merely so holds it that it may bring the little canes up to the requisite heat, so that when touched by the heated mass they may adhere to it. He then blows and expands the heated glass till it touches and takes up the white canes. The mass is then heated, drawn out, and rolled on the marver till the canes are flattened and thoroughly incorporated into the sides of the clear glass in the middle; the whole is then coated over with clear glass. This lump is then pulled out and shortened; one man holds it with one hand on the arm of his chair, while another gradually draws it out and twists it.

During this process he varies these twists by holding the glass in at intervals, and other clever turns of the hand. The white lines may run round a central white line, inserted previously into the clear glass, or round a colored one.

When these filigree canes have been twisted and drawn out to the thickness of a quarter of an inch or so, short lengths, perhaps of a series of these compound canes of different patterns, are themselves incorporated into a fresh center of clear glass, and blown into a globe or a vase, which then has alternate stripes of filigree and clear glass running up its surface or spirally round it. We see dishes and vases in which the white or colored lines cross each other in what we may call engine-turned reticulations. One method of this operation is said to be by blowing a globe of glass out of a piece in which the white has been twisted spirally and in one direction. The lower half is then pushed up inside the upper, and a reverse set of spiral lines is added, and the glass thus doubled is dealt with to form a vase or dish, but I have never seen this operation performed.

Many of the larger glass vases have medallions of colored glass on their shoulders or round their sides. This is done by laying a lump of heated glass in the place desired, and stamping it at once as if with a seal on sealing wax. Vases are sometimes made with grotesque animals, such as stags, fishes, or birds, within them, or else the glasses themselves are in those shapes. These grotesque forms are said to have been intended for the mysterious pharmacy of the alchemist. The visitor to large museums will see an endless variety of these blown, twisted, and variegated vessels, dishes, bottles, etc., not to speak of the beautiful chandeliers in which the branches are interspersed with stems bearing colored flowers and crimped leaves. Chandeliers and complicated-looking glass frames are made up of many different parts, the making of which is simple enough when we examine these compositions in detail.

8. I must now advert to a mixture of fragments of colored glasses welded in the metal state and veined in the manner of marbles, out of which ornamental glass vessels are blown; this is called *schmelz*. Glass is also made to take up minute pieces of gold leaf or of copper, which are incorporated into the mass, and forms a costly-looking material called *avanturine*. Many of the decorative additions to Venetian vases, etc., are made in avanturine glass. Another product of combined pieces of glass consists of sections of cane arranged as stars and flowers, and bedded in clear metal, forming a mosaic. Paper weights, and other masses of this kind of glass, have long been made by the glass makers of Murano for the European markets.

9. The processes we have been considering are properly the work of glass blowers, but glass vases have been made in Venice, and still more in Germany and other northern countries, who borrowed the art of glass making from the Venetians, with heraldry and other ornaments painted on the surfaces with enamel. The colors are made up with some metallic flux, or with glass reduced to powder, which melts, when exposed to a moderate heat, sufficient to heat the surface of the vessel, and becomes incorporated with it.

Cylindrical vases, decorated with enameled paintings, made in Bohemia, and in various parts of Germany, are to be seen in most collections. Other methods of decorating glass are by moulding, cutting, and engraving. Glass moulding is done by blowing the glass into a mould. Moulds are now made of metal, but I believe it is a question whether in ancient glass wood was used, or wood coated with some composition. In any case, glass is blown into the mould till it reaches the sides, and receives the pattern or design prepared for it. The mould, which is hinged in two or more parts, is opened as soon as the glass cools, and the vessel retains its fire polish.

10. Cutting is performed by applying the glass vessel to the edges of a disk of sandstone, with a sharp edge, revolved by a treadle, and on which sand and water are made to trickle. The cuttings are next smoothed on a disk of slate or some fine stone, and are finally polished on a grinder of cork, with putty made of some product of lead. Facets, stars, and other simple patterns are made by these means. For more delicate work, a copper disk is employed, not larger than a shilling, or smaller still, and finally, the graver.

Cutting of a fine kind, in elegant designs, is found on many of the Venetian vessels of the 16th and 17th centuries. There are vases in the Kensington Museum, of German-Venetian workmanship, with figures on the surface, etched, apparently, with a diamond, and of the utmost fineness and delicacy.

Venetian 17th century looking-glasses are found with figures cut on the backs, which are left rough, and show like dead silver. When certain designs, such as scrolls foliage, and the like, are polished as well, and in all their parts, they add extraordinary delicacy and luster to the glass or vessel on which we find them, and impart to it some of the charm which belongs to cut and polished rock crystal. So far, then, as to the general operations of the art now under discussion.

11. Considering, next, the knowledge of chemistry, and the connection of that science with the making of glass itself, one would be inclined, at first sight, to say that glass can only be the product of a scientific age. As a science, chemistry is of comparatively modern growth. Yet glass making has a far-reaching history. In many respects the composition of the material, and certainly its artistic treatment, has been carried further by the ancients than by ourselves. The antiquity of glass is proved both by paintings in the ancient tombs of Egypt of the 4th dynasty, between 3,000 and 4,000 years old, and by specimens, still sound and entire, which have been recovered from them, and can be seen in the British and other museums. Whether Egypt is the country of its actual invention is disputed. The Romans claimed it as an accidental discovery of Phœnician traders. As a fact, the art was carried from Egypt to Syria; to Sicily; round the Mediterranean, to Asiatic Greece; and finally to Rome. Alexandria continued, for a long period, a principal seat of the manufacture. Tyre was another. It was established on Monte Cœlio, in Rome, and elsewhere in Italy, in the time of the early Cæsars, and the beautiful colored drinking cups then made or imported were highly valued by them. A story is told of a maker who, when the Emperor Tiberius spoke of the fragility of his wares, dashed down, or let us suppose let fall, a glass cup, which was uninjured by the action. It is conceivable that the process of making unbreakable glass, as now practiced, may have been known in those days.

12. Among the productions of Egyptian glass makers must be reckoned that of artificial precious stones. Some of them were of an astonishing size: A statue of Serapis, 13 feet high, of emerald; an emerald given to a Pharaoh by a Babylonian king, six feet by four feet, in this case of Asiatic manufacture. Some large pieces survived those ancient times and are still surviving in church treasuries, which were believed to be colossal emeralds in the middle ages, and were highly valued accordingly. We hear of a table made of a single emerald, found by the Arab conquerors of Spain.* The colors of such slabs, or blocks, of this material as are now extant are of extraordinary richness and beauty.

The Kensington Museum possesses a number of dishes, vases, bottles, and fragments of green, amber, amber brown, sapphire blue, and schmelz of great beauty. The canes, of which the mixed glass vases contained sections, are twisted and rolled together in the manner described, as regards Venetian glass, but far surpass such examples as I have seen. They can scarcely be represented by photography. The light must be seen through them and on them, in order to the full appreciation of their splendor.

13. The Romans were luxurious and costly in the decoration of their houses, especially of their dining rooms, in which the important business of the day was carried on. They devoted much splendor to the ceilings of these rooms, which were paneled and coffered in various ways, and the inclosed spaces were gilt and inlaid, among other materials, with little decorative mouldings of colored glasses. There are fragments of sapphire blue moulded glass decoration at Kensington which seem to have been made for this purpose.

14. Among the more costly glass productions of ancient times we must reckon dishes and vases, cut, like cameos, from colored glasses coated with opaque white glass, the parts not required for the design being cut down to the translucent ground. The Portland vase in the British Museum is a beautiful example. A vase of two colors of glass, one opalescent, the designs in high relief, was exhibited at Kensington some years ago by a member of the Rothschild family. There is a fragment of a figure, the drapery only, modeled in very low relief on blue ground, at Kensington. The drapery shows that the entire figure must have been nearly a foot high.

15. Sefer Nameh, an Oriental traveler, who wrote a journal between 1035 and 1042, speaks of green glass, made in the suburbs of Cairo, in his day, and of furnaces at Tripoli and elsewhere on the Syrian coast. Of Oriental glass, the most noteworthy examples that can be referred to are the lamps formerly hung in the Arab mosques of Cairo and other cities. Indeed, few more beautiful examples of decorative glass can be seen anywhere. They are in the form of bowls on flat stands with wide funnel-shaped necks, and loops on the shoulders for suspension. They appear to have been made of common glass. In the structure of it you observe specks and bubbles, and they have a horny look, perhaps from their age and the constant presence of oil about them. The decoration consists of bands of red or blue enamel color, and legends written in fine Arabic characters, clear glass on the colored bands and *vice versa*. The legends express pious ejaculations, quotations from the Koran, and the names of reigning princes or donors. There are several examples of these lamps at Kensington, and some of small size of other shapes. A large collection has been made at Cairo, and some of those examples were lent at one time for exhibition at Kensington. The glass houses of Alexandria, Tyre, and other Mediterranean cities turned out these beautiful lamps during the 14th and 15th centuries. But they were made also in Venice to order during the same period. The Persians were the chief customers. Persian workmen were possessed of extraordinary skill in repairing broken glass, but were not successful in making these lamps for themselves. Persian glass vases and *mille fiori* work of great beauty will be seen in the South Kensington Museum.

16. The ancient Roman industries, and the best artists of the 4th century, were transplanted bodily by Constantine to his new capital, Constantinople, and it was from the Greeks of the Eastern empire that the glass maker's art was recovered in the middle ages, when Italy emerged from the ruin of barbarous invasions. The Venetian islands offered a refuge for such refugees from the mainland as they could support. It is claimed by Venetian annalists, and I incline to believe justly, that this glass industry has been preserved by the republic, even from Roman times. However that may be, it seems to be from the Greek artists who were received in Venice after the sack of Constantinople, at the beginning of the 13th century, that the finer treatment of glass took its renewed traditions. This industry grew and prospered. Two centuries later, the Eastern empire was overthrown, and a more general immigration of artists and learned men took place into Western Europe. It is from this time that the Venetians encouraged the manufacture not only of beads and imitation jewels, but fine glasses and vases. The island of Murano became the chief seat of the glass houses of the republic. Severe laws were passed, forbidding the emigration of skilled workmen, and a sort of home rule was granted to the little island, and many social privileges were conferred on the leading members of the guild or craft. We have already spoken of the kind of work produced. When the fashion of cut glass came in, during the last century, Venetian glass making declined.

17. German princes and governments took great pains during the 16th and 17th centuries to introduce Venetian glass work within their own borders. Workmen were enticed and smuggled into these states, and some fine blown glass vessels were made in various countries. It has been maintained that the fine Venetian pieces on which the imperial eagle and other German insignia are worked must be of German origin; but, as glass was made for half the princes and noblemen of Europe, in Venice, in many cases to special order, in others as diplomatic presents from the government, we ought, I believe, to credit examples of this kind to the makers of Murano. It is true, however, that in Germany and Flanders, Venetian vases and glasses, more or less decorated, were produced, but the very finest examples were probably imported. As regards German 17th century glass, heraldry, and inscriptions in enamel painting, or engraving, form its chief decoration.

The government of Louis XIV. took as much pains to smuggle glass makers into France as it did for lace making and other highly skilled industries. Fine examples of cut glass chandeliers, looking-glasses, blown glasses, and other old French glass work are still to be met with.

18. As regards our own country, the making of common window glass was active from the 7th century. By the middle of the 16th it was established at Crutched Friars. In 1673, the Duke of Buckingham brought Venetian workmen over, and settled them in Lambeth. Their principal work was making mirrors of cast or flatted glass, with slightly beveled edges, and carriage windows. Such beveled glass was used for glazing the royal palaces and costly houses. Panes of it (of the 17th and early 18th centuries) can be seen now in the sashes of Wren's portion of Hampton Court. Wine bottles, to judge from an old one in our possession, were squat bulbous quarts, with the family crest stamped on the shoulder, wine being imported and bottled at home. The glass industry was for a time protected by state bounties.

The last century saw the end of many declining local industries. Twenty years of war ruined a vast number of porcelain, glass, and other establishments. England had fine potteries still, and exported these wares to the north of Europe and to the south. It is to be met with in Germany and Holland, and in Spain, but decorated glass was confined to cut table glass, chandeliers, and other work of which cutting is the chief ornament. Such chandeliers were to be seen in all theaters, halls, and ball rooms. The material was clear and lustrous, the prismatic pendants and hanging chains brilliant and effective, though not equal to the earlier productions of France. The brilliancy of these chandeliers goes far to redeem their weight and troublesomeness in cleaning. So, too, of table glass; but its great weight is a serious disadvantage, and its decoration is merely mechanical.

19. Great pains have been taken for some years past by our London and other manufacturers, both with the crystalline and brilliant quality of their flint glass and in the manufacture of colored glasses. A great impulse for the latter was given by the revival in France, and still more, and even passionately, in England, of mediæval art. Church restorations, at the expense of the government in the former country and by private persons in our own, led to the cultivation of glass painting, almost a lost art till of recent years. Willement and Gerente are names honorably connected with that movement, and the method of attaining the splendid hues of old window glass has been carefully studied. Commoner, inferior, and less crystalline glass is a better vehicle for color than flint glass, perhaps a more effective material for Venetian blown work.

Some years ago Sir Henry Layard, Sir William Drake, and others came forward to try and put new life into the glass works of Murano. They found funds, looked up workmen who still represented the old traditions, and so, under the energetic lead of Dr. Salviati, the decorative glass blowing of Venice has been revivified. All the old methods and many of the elaborate designs of the old artists have been put in practice. These Venetian processes have been carefully followed by some of our own leading glass makers.

Within the last few years some very beautiful cameo glass cutting has been executed, principally, I believe, by artists in the Stourbridge works. Some very successful examples were shown at Kensington in the Health Exhibition in 1884. There evidently is a hopeful future for this special branch of sculpture.

20. This brings me round to the point from which I started, the art as we see it now in our factories at home and in Venice. Both there and here the aim is the same, to restore the old methods and work them out with the old skill. Modern chemical knowledge ought to put us at an advantage over our ancestors as regards methods and compounds, and to make it clear whether modern furnace heating is better or worse than the former practice. But that rule of thumb which comes from long and unbroken experience is not to be recovered easily or soon. Seeing what accuracy of eye, what delicacy of touch, what grace in the action of the hand, are required for the finer productions of the blowing iron, it may be doubted whether the Italian has not a natural advantage over our northern workers. Joints and muscles matured under a southern sun are more supple and elastic than the hardier and stronger arms of the colder latitudes. But the feeling and spirit that inspires the artist emanate not from his fingers, but from his mind. I have no desire to enter on the thorny path of abstract principles regarding this or other arts. Too much has been said on that head, and said a great deal too often. I prefer to speak of the art of glass making, so pure, so fresh, so luminous in its creations, as a tradition with some 3,000 years or thereabout at its back. Though the Venetians threw themselves into the Greek traditions, as they came down to them, I have little doubt but that they pushed the art of blowing and manipulating fused glass beyond any perfection attained by the Greeks of Byzantium, perhaps by the ancient Greeks; but of that we have not sufficient ground for judging. They do not, however, seem to me to have come near the ancients in compounding those precious materials imitative of emerald and other costly crystals, out of which were made the cups and bowls to which I have already referred. I think this is a kind of perfection from which the Venetians, and we ourselves, are still far removed. So we still are from such sculpture as we see in the Portland vase.

21. Now for a word or two as to our modern English-Venetian and as to modern Venice-Venetian blown work. Much of it is of great beauty, and where dec-

* "Ancient and Modern Furniture," lxii.

orations of colored glass and avanturine are employed, it is skillfully done. But comparing it with 16th century work, we are struck by a glaring and over-showy look about it, and an absence of refinement. What we call good taste in art is a delicate and instinctive appreciation of the suitableness, the propriety, and fitness of decoration, which accord with the natural limitations of the material employed. A glass, or a vase, is set off by a certain amount of ornamental detail of colored glass, or of other decoration. But the color should be sparingly used, and should not be of many, very generally not of two, colors. The colored parts are like jewelry on a lady's neck. We must not ask her to suspend it from her nose as well as her ears, or load her with many-colored varieties. Each addition will detract from the value of those already hung. Avanturine, again, is a gold glass, or passes for it. This material, so valuable in appearance, must not be, as it too often is, in such proportions as to lose its decorative value. As to cut glass, chandeliers and table glass so decorated have a splendor of their own. But what are we to say to a huge throne, a sort of *tour de force*, made of vast masses of moulded and polished glass; or to fountains, such as I have seen in some of our vast international exhibitions? I doubt whether any absolute novelties are in store for us in this branch of human industry. But lost ground we have still much to recover. The bane of modern artistic industries is the popular demand for a novelty, even though a novelty should be monstrous.

Shall we ever make again those masses of splendid material, jewel-like in color, containing something like crystalline light within them, and those colors, not only the primary and secondary colors of the middle ages, which indeed we already have, but those tertiary colors which the ancients contrived to reach?

Every generation has some qualities of mind which are its own, every nation has its natural aptitudes and aspirations. By these the traditions of art, and more especially of artistic industries, take a definite character if genuinely carried out. We read it on the surface of the production of ages and of nations, and when we see it we say this or that piece of work is of such and such a time and country. If we are faithful to the laws which trained the artists of older days, we shall acquire confidence, and become artists in our turn. Our work will be thorough, and have new life in it, though our ways will be old ways still.

ELECTROMAGNETIC MACHINE TOOLS.*

BY F. J. ROWAN, of Glasgow.

THE electromagnetic machine tools devised by the author, and forming the subject of the present paper, are the result of his endeavor to overcome the difficulties of riveting the plating of ships by other means than hand labor. The conditions of the work itself involve the separation of the riveting or hammering portion of the apparatus from the bolster or holder-up, while on the other hand the conditions of the process of riveting require that the two portions of the machine should be rigidly held together; and in consequence of these conflicting requirements, the application of machine riveting to this class of work has not been a promising field for experiment. Almost the only method hitherto possible of uniting the two parts of the riveting apparatus has been by bolting them together by bolts passing through the rivet holes. It has been found, however, that this requires too much labor and time; and it also leaves a number of vacant holes which cannot be reached by the machine, and must therefore be filled up and have the rivets closed by hand. One of the most successful of the machine ship riveters was that introduced by Mr. John McMillan, of Dumbarton, in 1876. The necessity for very frequent shifting of the attaching bolts was obviated by having the steam striker carried on a horizontal slide, which was bolted at its ends to the side plating of the ship, and embraced about the length of a plate; no method of mechanical holding up was included in

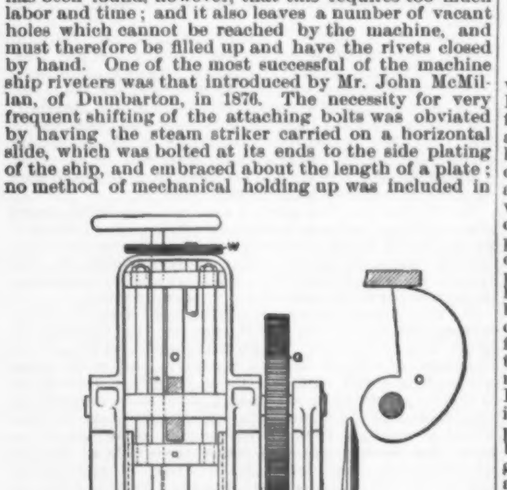


FIG. 1.

the plan. This arrangement, however, still left some rivets to be closed by hand, and continued to require manual labor for the holding up, which has been proved to be the most severe portion of the riveter's work. In spite of these drawbacks, the machine did some excellent work, and proved to the satisfaction of the surveyors of the Board of Trade and of Lloyd's Registry that the quality of the riveting done by machines in ship building is superior to that of hand work, in so far as regards the filling up of the rivet holes, on account of the machine blows being much heavier and more direct than those given by hand hammers.

Electromagnetic Riveting.—The use of electromagnets for the purpose of attaching the machine to its

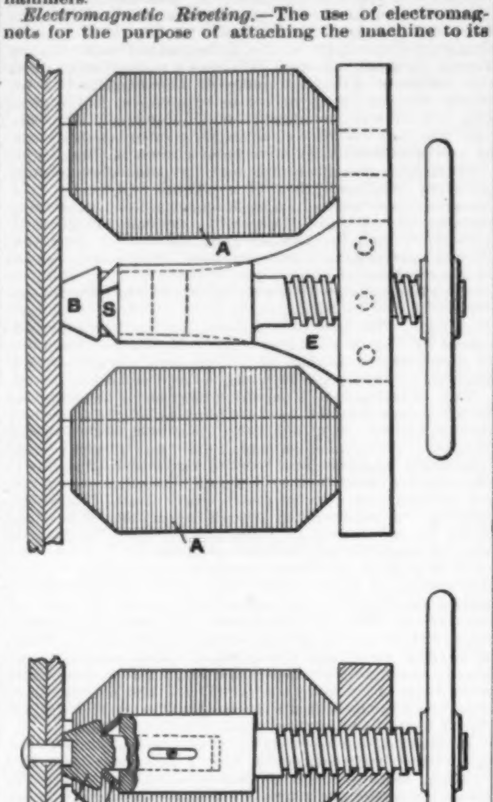


FIG. 2.

work satisfies the requirements in a very complete way. It gives a rapid method, practically instantaneous, of fixing the riveting portion of the machine to the work, and leaves no rivet holes to be afterward filled up by hand. The bolster or holder-up is as quickly attached on the other side of the plating. When the magnets are properly arranged on opposite sides of the plating, with the two poles of unlike denominations facing each other, they are drawn toward each other, thus pressing the plates together and insuring the proper condition for riveting. The effect of bolting the two portions of the machine together through the rivet holes is thus obtained without any attendant drawbacks, and the distressing work of manual holding up can be reduced to a minimum. In Fig. 1 is shown one form of the electromagnetic riveting machine; AA are the holding-on magnets, and M the motor, which by means of the gearing, G, and cam, C, lifts the hammer, H, against a spring, S. The amount of compression imparted to the spring in lifting is regulated by the position of the disk or piston, D, which can be adjusted by hand by means of the screw spindles, R, and spur gearing, W; the same mode of adjustment is equally applicable where springs are used in tension instead of in compression. The striking mechanism may of course be worked by other means than the cams shown in these diagrams. Hammers driven by steam, compressed air, water, or gas can be used with holding-on magnets; or the motor may be apart from the magnets, and the power transmitted by flexible shafting. The same remark also applies to the driving of the rest of the tools subsequently described. The holder-up is shown in Fig. 2; AA are the holding-on magnets, and the bolster or dolly, B, is kept to its work by the spring, S, which compensates the flattening of the rivet head during the operation of riveting. A curved arm or attachment, E, carries a small subsidiary bolster and spring, for insertion under the reverse bars of ships' frames or into confined spaces.

Drilling.—The application of the same principle to drilling, tapping, and other tools became apparent to the author as soon as the idea had occurred to him of constructing a riveter in this way. The application to drilling is, he thinks, even more important than to riveting, and is capable of a wider range of employment; because, while an electromagnetic riveter must compete with hydraulic, steam, and power machines, where these are practicable, the case is different with regard to drilling. The want of suitable drilling tools for ship building work has prolonged the continuance of the more imperfect system of punching; and the hand ratchet, which is in many cases the only alternative to the punching machine, is a very slow and inefficient appliance. The importance of substituting drilling for punching in the preparation of structures composed of plates and bars of steel, and even of iron, has been, by inference at any rate, very fully established. From a careful examination of the voluminous tables given in Professor Unwin's report to the Institution upon this subject, the results of the greater number of experiments made on iron and steel plates lead to the general conclusion that while thin plates, even of steel, do not suffer very much from punching, yet in those of ½ in. thickness and upward the loss of tenacity due to punching ranges from 10 to 23 per cent. in iron plates, and from 11 to 33 per cent. in the case of mild steel. In drilled plates, on the contrary, there is no appreciable loss of strength. It is even possible to remove the bad effects of punching by subsequent reamering or annealing; but the speed at which work is turned out in these days is not favorable to additional treatment. These facts lead irresistibly to the conclusion that the introduction of a practical method of drilling the plating of ships and other structures, after it has been bent and shaped, is a matter of very great importance. If even a portion of the 30 per cent. deterioration of tenacity can be prevented, a much stronger structure results from the same material and the same scantling. This has been fully recognized in the modern practice of the construction of steam boilers with steel plates; punching in such cases being almost entirely abolished, and all rivet holes being drilled after the plates have been bent to the desired form. The magnitude of the interests which are dependent upon the strength and therefore upon the security of ships is little, if at all, less than that of those which are affected by boiler safety. Electromagnetic drilling machines offer practically the same facilities for the work of ship building and for other operations as are already possessed in boiler making; but they differ from the drilling machines used in the latter process in this respect, that in using the electromagnetic drilling machines it is necessary to move only the smaller weight of the machine, instead of the larger weight of the boiler or other structure. This of course renders them applicable also to boiler making and other engineering work. In Fig. 3 is shown a simple form of drilling machine, in which AA are the holding-on magnets, M the motor axle, D the drill spindle, and F the feed of drill. After several trials of other forms, it has been found better to work either hammer or drill through an opening cut in the center of the yoke joining the two magnet cores, and to have the hammer shaft or drill spindle between the magnet poles instead of beyond their center line. The thrust of the hammer or drill is thereby distributed equally over both magnet poles. In some exceptional positions, however, convenience of working requires other forms, and machines may be made which will work satisfactorily although the above arrangement is departed from. An instance of such alteration in form is given in Fig. 4, which illustrates a drilling machine now at work with good results, the drill projecting beyond the magnets. Multiple and radial drilling machines, and several other kinds of machine tools, have also been designed on this system, as shown in Figs. 5 and 6.

Tapping.—The operation of tapping stay bolt and other holes can also be carried out rapidly by power by means of electromagnetic machines, instead of very slowly by hand as at present. In using an electro-

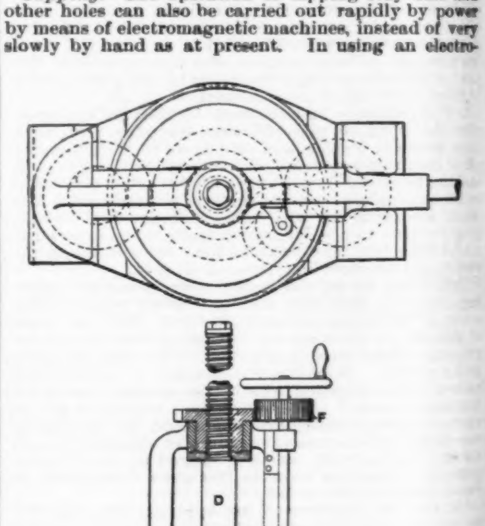


FIG. 3.

motor for working the tapping bar, there is the advantage of its direction of motion being easily and quickly reversed, in order to rapidly withdraw the tapping bar. The tapping machine is similar in general design to the drilling machine shown in Fig. 3. No feeding screw is required in this case, as the tapping bar feeds itself forward as soon as a thread is formed. Consequently only a lever is provided, for giving the needed pressure on the head of the tapping bar, in order to start the cut.

* From a paper recently read before the Institution of Mechanical Engineers, Edinburgh.—*Industries.*

Caulking and Chipping.—These operations are also quite under the control of electromagnetic machines. Frames to serve as guide bars are attached to the work by electromagnets or otherwise, in such a position that a long range of seam or surface is commanded by the machine when moved along these guides. The chipping or caulking tool is regularly and quickly struck by a power hammer, which is worked by an electromotor or by a solenoid or otherwise, as is convenient. In Figs. 7 and 8 are shown forms of caulking and chipping tools, that in Fig. 7 being worked by small motors, and that in Fig. 8 by a solenoid. An electromagnet is shown attached to each of these tools; and in Fig. 9 is shown the guide bar arrangement, by means of which the tools without holding-on magnets can be moved along through a considerable range.

A general idea is given in Fig. 10 of the side plating in sectional plan, several tools, such as a steam riveter, a spring hammer, and an electric hammer, working on the same guide bar or frame. When the holding-on magnets of the tool are released, the tool drops down on the guide bars, along which it can then be shifted, and the attractive force of the magnets is sufficient to raise it back again to its working position.

Practical Results.—With a view to ascertaining practically the conditions essential to successful work, one or two trial machines were constructed, which, although imperfect, were useful in enabling experience to be acquired of the kind desired. After a very small amount of practice, the men working the machines drilled the $\frac{7}{8}$ in. holes in the shell with great rapidity, doing the work at the rate of one hole every 69 seconds, inclusive of the time occupied in altering the position of the machines by means of differential pulley blocks, which were not conveniently arranged as slings for this purpose. Repeated trials of these drilling machines have also shown that, when using electrical energy in both holding-on magnets and motor amounting to about $\frac{3}{4}$ h.p., machines of the form illustrated in Fig. 3 have drilled holes of 1 in. diam. through $1\frac{1}{8}$ in. thickness of solid wrought iron or through $1\frac{3}{8}$ in. of mild steel in two plates of $\frac{11}{16}$ in. each, taking exactly $1\frac{3}{4}$ minutes for each hole. The machine illustrated in Fig. 4, which has magnets of less holding power, when using only about

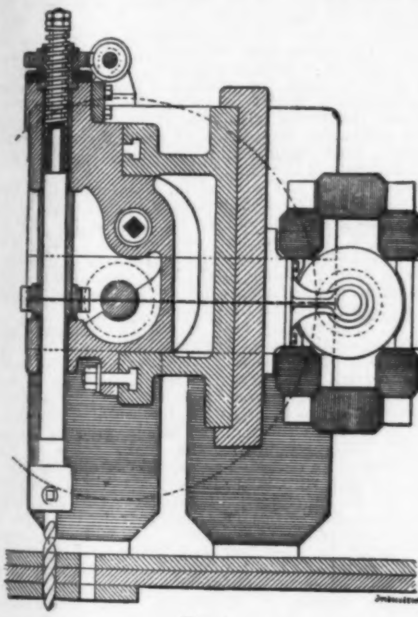


FIG. 4.

0·6 h.p. of electrical energy, took the same time to drill holes of $\frac{13}{16}$ in. diam. through wrought iron of $\frac{13}{16}$ in. thickness. As regards speed of drilling, the author believes these results are equal to any obtained by machines using much greater power. With the hammer shown in Fig. 1, using an electromotor giving out $\frac{1}{2}$ brake h.p., from 100 to 150 blows per minute have been obtained, with a force of impact equal to about 180 ft. lb. per blow, as nearly as could be ascertained. This is much greater than the force of blow given by hand hammers weighing 6 lb., and striking as heavily as is possible in staving up. At the works of Messrs. Immisch in March last, this riveter was seen closing 1 in. rivets in 10 seconds each. The electromotors used by the author in the machines constructed for Mr. McMillan, with which these results have been obtained, were of Messrs. Immisch's design and manufacture, and the author believes they will not readily be surpassed. After seeing the machines at work in Messrs. McMillan's yard, Messrs. William Denny & Brothers constructed an electrical drilling machine having a modification of the traversing frame illustrated in Fig. 10, but without holding-on magnets, and applied this machine to drilling the rivet holes in the butt joints of a large steamer. The drilling machine illustrated in Fig. 3 has also been successfully used for drilling holes of $1\frac{1}{4}$ in. diam. in the engine seat of the S.S. Pukaki, under the direction of Mr. Archibald Denny, of whose co-operation and assistance the author has had the benefit in the early working of his machines.

In designing the earliest machines on this system, the author was without any data which were of use as a guide in determining sizes of electromagnets or of electromotors for the various requirements of different machines. Most of the investigations into the elements of electromagnets have hitherto been directed to questions affecting their use under the conditions found in dynamo machines. Consequently, expressions of their efficiency which are to be found in published treatises are given in terms chiefly of the intensity of the magnetic field, and not with reference to their holding or, as it is called, lifting power, which is the quality made use of in the machines here described. From a number of experiments which he has made with apparatus of different dimensions, the author has, however, obtained results which promise to yield the elements for

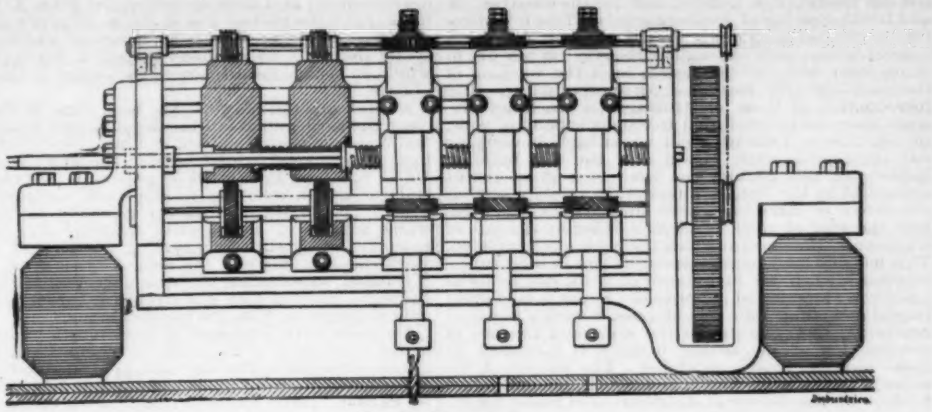


FIG. 5.—ELEVATION.

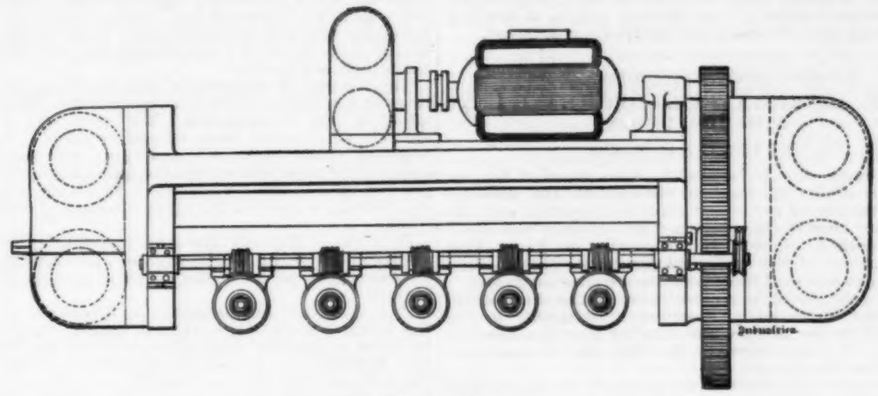


FIG. 6.—PLAN.

MULTIPLE DRILLING MACHINE.

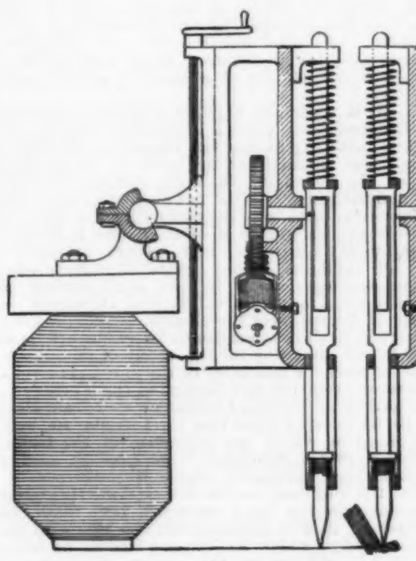


FIG. 7.

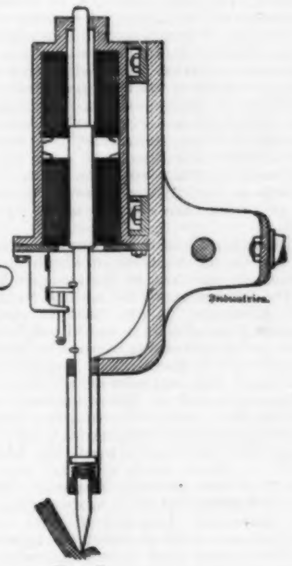
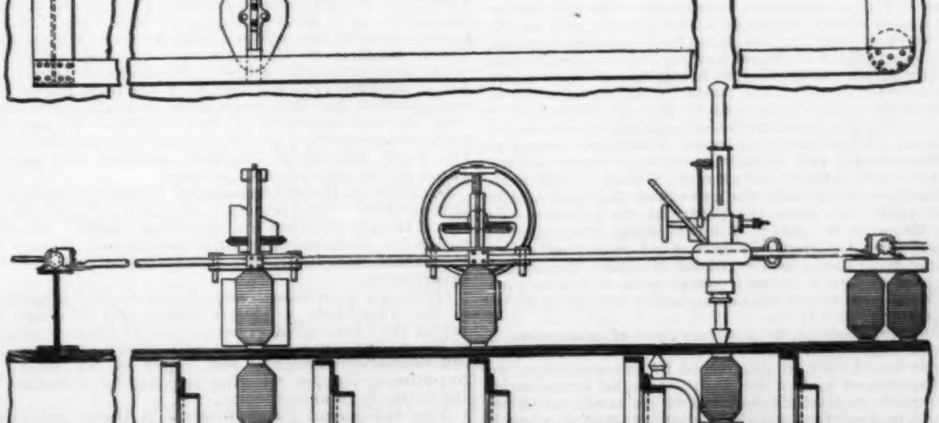


FIG. 8.

CAULKING TOOLS.



FIGS. 9 AND 10.

SLIDING FRAMEWORK TO CARRY TOOLS.

ELECTROMAGNETIC MACHINE TOOLS.

the statement of a general law for the construction and holding power of electromagnets. This investigation is not yet completely worked out, but it is under consideration; and the author reserves an account of it, together with further results from the working of the machines now described, for another paper. The introduction of these electromagnetic machines presents also some interest from an economic point of view, in addition to their practical advantages in carrying out engineering work. Until now the ship building industry of this country has been to a great extent controlled by the trades union of the riveters, so that employers of labor have been unable always to regulate the cost of work as affected either by the rate of wages or by the speed at which the work was completed. This has told most heavily against them in busy times, especially when an abundance of work has followed quickly on a period of depression. Hence it is of great importance that they should possess such a means of controlling both the cost of the work and the rate of construction as the author believes is furnished by these electromagnetic machines. The subject of the present paper forms the threshold of the still larger subject of the electrical distribution of power for engineering operations in general, and the author believes it will be found both economical and otherwise convenient to adopt electrical distribution in engineering workshops, instead of the existing system of shafting and belts, or even hydraulic distribution of power.

[Continued from SUPPLEMENT, No. 608, page 9713.]

WHAT AMERICAN ZOOLOGISTS HAVE DONE FOR EVOLUTION.*

By EDWARD S. MORSE.

To those who have already been startled by the memoir of Dr. W. Baldwin Spencer on the presence and structure of the pineal gland in Lacertilia and the evidence that it represents a third eye in a rudimentary condition, it will be interesting to know that among some of the earlier mammals the pineal gland may have assumed functional importance as an eye.

Professor Marsh, in a description of the skull of Diplodocus, a Dinosaur, describes a fontanelle in the parietal on the median line directly over the cerebral cavity. He adds, however, that this may be merely an individual variation.

Professor Cope observes an enormous fronto-parietal foramen in the skull of *Empedocles molaris*, a curious creature from the Permian.

It would appear evident from these facts that at one time the pineal gland, which in the mammals is in a rudimentary condition, and in certain Lacertilia sufficiently perfect, as an eye, to be sensitive to light impressions at least, was, in certain extinct mammals and reptiles, of large size and functionally active. It is a significant fact that no sooner does some one opposed to evolution undertake to lay down the law by setting a boundary to type features, than a discovery is made that breaks down the barrier. Thus Dr. Thomas Dwight in an interesting memoir on the "Significance of Bone Structure," in which he makes a brave defense for teleology, says, in speaking of the persistence of the vertebrate plan, "There are never, for instance, more than two eyes or one mouth or two pairs of limbs," and, lo! an extra eye is immediately added.

Dr. Spencer Trotter has made a study of the collar bone and its significance, in which he accounts for its presence or absence in mammalia by correlating it with the life habits of the animal in the use of the fore limb. He says: "Every fully developed tissue in an organism is needed or it would not be there; and just so soon as by increasing change in life and habits it becomes a factor of less and less importance to the animal, it fails more and more to attain its former standard of development, and in time falls back to the primitive condition from which it arose, and finally disappears."

Many new and interesting facts have been added sustaining the affinity between the birds and reptiles. Prof. O C. Marsh made a careful study of the Archæapteryx in the British Museum. The new points he has added bring out still more strongly the extraordinary characters blended in this creature. Among other features he discovered the separate condition of the pelvic bones, and shows that while it must be considered a bird, yet it has true teeth, bi-concave vertebræ, three separate fingers in each hand, all furnished with claws, metatarsals and metacarpals, equally unanchylosed, and the pelvic bones separate, as already mentioned.

Dr. J. Amory Jeffries, in a study of the claws and spurs on birds' wings, has presented an interesting table showing the number of phalanges in each finger, from the highest to the lowest family of birds, with the presence or absence of claws recorded for each finger. This table shows very clearly that the higher birds have fewer phalanges and no claws, and as one approaches the lower families the phalanges increase in number, the first finger having two phalanges and the second and third fingers being tipped with claws.

In a brief study of the tarsus of low aquatic birds, made with special reference to the interpretation of the ascending process of the astragalus with the intermedium of reptiles, I observed a separate center of ossification for this so-called process, observed its unquestionable position between the tibiale and fibulare, its increase in size with the growth of the bird, and its final anchylosis with the proximal tarsal bones. In the bones of a young Dinornis which, through the courtesy of Dr Henry Woodward, I was kindly permitted to examine in the British Museum, the ascending process was large and conspicuous and firmly anchylosed with the co-ossified tarsals to the distal end of the tibia.

The question as to the existence of a sternum in Dinosaurian reptiles has long been in doubt. Professor Marsh has, however, discovered in Brontosaurus, one of the largest known Dinosaurs, two flat bones which he regards as clearly belonging to the sternum. They correspond to the immature stage of similar parts in birds.

Dr. Alexander Agassiz in a study of the young stages of certain osseus fishes shows that while the tail is a modified heterocercal one, it is for all that in complete accordance with embryonic growth and paleontological development; and independently, Dr. John A. Ryder finds that "the median fins of fishes normally present five well-marked conditions of structure which correspond inexactly to as many stages of development, which, in typical fishes, succeed each other in the order of time."

A great amount of work has been done in making clear the earlier stages in the development of animals and breaking down the hard and fast lines which were formerly supposed to exist between the larger divisions. Dr. C. S. Minot, in a series of papers on comparative embryology, in referring to the work accomplished, says: "These researches have completely altered the whole science of comparative anatomy and animal morphology by entirely upsetting a large part of Cuvier's classification, and the idea of types upon which it is based, substituting the demonstration of the fundamental unity of plan and structure, throughout the animal kingdom, from the sponges to man."

Professor C. O. Whitman, in describing a "rare form of the blastoderm of the chick, in which the primitive groove extended to the very margin of the blastoderm, terminating here in the marginal notch first observed by Pander," justly contends that "in the origin of the embryo from a germ ring by the coalescence of the two halves along the axial lines of the future animal, and, secondly, in the metameric division which followed in the wake of the concrescence," we have evidence of the annelidan origin of the vertebrates, since concrescence of the germ bands is a well-established fact for both chætopods and leeches.

The tracing of apparently widely divergent structures to a common origin has engaged the attention of many of our investigators. Not only has a large amount of evidence been offered to show a common origin of widely separated structures, but memoirs of a speculative and theoretical character have given us a possible clew to the avenues we may follow in further establishing a proof of the unity of origin of forms and parts.

Dr Francis Dercum gives an interesting review of the structure of the sensory organs, and urges that the evidence goes to prove the common genesis of these organs.

Prof. A. Hyatt has presented an interesting study of the larval history of the origin of tissue. He attempts to show a phyletic connection between the Protozoa and Metazoa, and also to show that the tissue cells of the latter are similar to asexual larvæ, "and are related by their modes of development to the Protozoa, just as larval forms among the Metazoa themselves are related to the ancestral adults of the different groups to which they belong." Dr. John A. Ryder has studied the law of nuclear displacement and its significance in embryology. In a discussion of this subject he says: "The mode of evolution of the yelk is of great interest, and doubtless occurred through the working of natural selection. It is evidently adaptive in character, and the necessity for its presence as an appendage of the egg grew out of the exigencies of the struggle for existence."

Mr. H. W. Conn, in a paper entitled "Evolution of the Decapod Zoæ," gives a number of striking and suggestive facts explaining the reason of the multiform and diverse character of the larvæ of Decapod Crustaceans. He shows in what way natural selection has affected the young. What has seemed an almost insoluble mystery, as to why the early stages of closely allied Crustaceans should be so often diverse in their varied armature of long spines, their powers of rapid flight, etc., are explained on the ground of natural selection. In an another memoir by the same author on the significance of the "Larval Skin of Decapods," a very complete discussion of the views of authors is given. At the outset he shows that the Crustaceans are a particularly favorable group for the study of phylogeny, and then suggests the character of the ancestral form of the Crustacea from the significance of the larval envelope. The author infers from his studies that "all Decapods are to be referred back to a form similar to the Protozoæ (Zoæ), in which the segments of the thorax and probably of the abdomen were present, and whose antennæ were locomotive organs."

Not the slightest justice can be done this admirable discussion in the brief reference here made, but the perusal of it will certainly impress one with the profound change which has taken place in the method of treating a subject of this nature compared to the treatment it might have received in pre-Darwinian days. Indeed, the features discussed in this paper would not have attracted a moment's attention from the older naturalists.

Since Darwin published his provisional theory of Pangenesis, it has provoked speculative efforts on the part of some of our naturalists to devise other hypotheses which might answer some of the objections urged against Darwin's hypothesis. Space will permit only a mention of a few of these papers. Prof. W. K. Brooks presented, in a brief abstract at the Buffalo meeting eleven years ago, a provisional theory of Pangenesis. These views more elaborated are now published in book form under the title of "The Laws of Heredity." An illustrious reviewer says it is the most important contribution on the speculative side of Darwinism that has ever appeared in this country. He has also aptly termed studies of this nature molecular biology. Dr. Louis Elsberg at the same meeting also read a paper on the plastidule hypothesis.

Dr. John A. Ryder has made an interesting contribution entitled "The Gemmule *versus* the Plastidule, as the ultimate physical unit of living matter." In this paper he discusses Darwin's provisional theory of Pangenesis, and shows it to be untenable from Galton's experiments.

Haeckel's provisional hypothesis of the Perigenesis of the Plastidule is clearly stated, and he closes by saying that the logical consequences of the acceptance of Haeckel's theory, and with it the theory of dynamical differentiation—because the latter is no longer a hypothesis—forever relegates teleological doctrines to the category of extinct ideas.

The widespread public interest in Darwinism arose from the fact that every theory and every fact advanced in proof of the derivative origin of species applied with equal force to the origin of man as one of the species. The public interest has been continually excited by the consistent energy with which the church, Catholic and Protestant alike, has inveighed against the dangerous teachings of Darwin. Judging by centuries of experience, as attested by unimpeachable historical records, it is safe enough for an intelligent man, even if he knows nothing about the facts, to promptly accept as truth any generalization of science which the church declares to be false, and conversely to repudiate with equal promptness, as false, any interpretation of the behavior of the universe which the church adjudges to be true. In proof of this sweeping statement, one has only to read the imposing collection of facts brought together by Dr. White, the distinguished ex-president of Cornell University, which are embodied in his work entitled "The Warfare of Science," as well as two additional chapters on the same subject which have lately appeared in the *Popular Science Monthly*. One then realizes the lamentable but startling truth that, without a single exception, every theory or hypothesis, every discovery or generalization, of science has been bitterly opposed by the church, and particularly by the Roman Catholic church, which resists and, as Huxley says, "must, as a matter of life and death, resist the progress of science and modern civilization."

Only the briefest reference can here be made to a few of the numerous contributions on the subject of man's relationship to the animals below him. The rapidly accumulating proofs of the close relation existing between man and the quadrumana make interesting every fact, however trivial, in regard to the structure and habits of the higher apes.

Dr. Arthur E. Brown has made some interesting experiments with the monkeys at the zoological gardens in Philadelphia. He found that the monkeys showed great fear, as well as curiosity, when a snake was placed in their cage, though they were not affected by other animals, such as an alligator and turtle. On the other hand, mammals belonging to other orders showed no fear or curiosity at a snake. These experiments, repeated in various ways, lead him to only one logical conclusion, that "the fear of the serpent became instinctive in some far distant progenitor of man by reason of his long exposure to danger and death in a horrible form from the bite, and it has been handed down through the diverging lines of descent which find expression to-day in the genus Homo and Pithicus."

The same author, in an exceedingly interesting description of the higher apes, says: "Mr. A. R. Wallace once called attention to the similarity in color existing between the orang and chimpanzee and the human natives of their respective countries. It would, indeed, seem as if but half the truth had been told, and that the comparison might be carried also into the region of mind; the quick, vivacious chimpanzee partaking of the mercurial disposition of negro races, while the apathetic, slow orang would pass for a disciple of the sullen fatalism of the Malay."

Doctor Brown has also given a description of the grief manifested by a chimpanzee on the death of its mate. His grief was shown by tearing his hair or snatching at the short hair on his head. The yell of rage was followed by a cry the keeper had never heard before, a sound which might be represented by hah-ah-ah-ah-ah uttered somewhat under the breath, and with a plaintive sound like a moan.

Mr. W. F. Hornaday read at the Saratoga meeting of this association an exceedingly interesting paper on the "Habits of the Orang" as observed by him in its native forests. He says: "Each individual of the Borneo orangs differs from his fellows, and has as many facial peculiarities belonging to himself alone as can be found in the individuals of any unmixed race of human beings." After recounting the many traits of the orang heretofore regarded as peculiar to man, he says: "Let any man who is prejudiced against Darwinian views go to the forests of Borneo. Let him there watch from day to day this strangely human form in all its various phases of existence. Let him see it climb, walk, build its nest, eat and drink and fight like human 'roughs.' Let him see the female suckle her young and carry it astride her hip precisely as do the Coolie women of Hindostan. Let him witness their human-like emotions of affection, satisfaction, pain, and childish rage—let him see all this, and then he may feel how much more potent has been the lesson than all he has read in pages of abstract ratiocination."

Prof. W. S. Barnard several years ago, in a study of the myology of man and apes, showed that the scansorius muscle which Trail studied in the higher apes, and which he supposed had no homologue in man, was really homologous with the *glutæus minimus* in man. Dr. Henry C. Chapman, in a study of the structure of the orang-outang, has confirmed the truth of Barnard's discovery. Dr. Chapman is led to infer that the ancestral form of man was intermediate in character, as compared with living anthropoids or lower monkeys, agreeing with them in some respects and differing from them in others.

The osteological affinities which man has with the Lemuroidæ, as insisted upon by Mivart, are also recognized by Cope. In a general paper on the "Origin of Man and Other Vertebrates" he says: "An especial point of interest in the phylogeny of man has been brought to light in our North American beds. There are some things in the structure of man and his nearest relatives, the chimpanzee, orang, etc., that lead us to suspect that they had rather come from some extinct type of lemurs."

It would seem as if we must look further back than the higher apes for the converging lines of man's relations with them. The earliest remains of man or the apes found fossil, presenting as they do marked types with little tendency to approach each other, would in themselves suggest an earlier origin for both stocks.

In a paper by Professor Cope on "Lemurine Reversion in Human Dentition" he says, in concluding his article, "it may be stated that the tritubercular superior molars of man constitute a reversion to the dentition of the Lemuridæ of the Eocene period of the family Anaptomorphidæ, and second, that this reversion is principally seen among Esquimaux and the Slavic, French, and American branches of the European race."

In another paper by the same author, on the "Developmental Significance of Human Physiognomy," he compares the proportions of the body and the facial peculiarities of man with the higher apes and human infants, and shows that the Indo-European, on the whole, stands higher than the other races in the acceleration of those parts by which the body is maintained in an erect position, and in the want of

* Address of the retiring President of the American Association for the Advancement of Science, New York, August 11, 1887.

prominence of the jaws and cheek bones, which are associated with a greater predominance of the cerebral part of the skull and consequently greater intellectual power.

Dr. Harrison Allen, in a study of the shape of the hind limb as modified by the weight of the trunk, dwells on the manner of articulation in the gorilla of the fibula with both calcaneum and the astragalus, as well as the fact that the astragalus in that genus possessed a broad deflected fibula facet, and says "this peculiar projection is rudimental in the astragalus of civilized man, but was found highly developed in an astragalus from an Indian grave found at Cooper's Point, New Jersey."

In my Buffalo address I alluded to a paper by Prof. N. S. Shaler on the intense selective action which must have taken place in the shape and character of the pelvis in man on his assumption of the erect posture—the caudal vertebræ turning inward, the lower portion of the pelvis drawing together to hold the viscera, which had before rested on the elastic abdominal walls, the attending difficulty of parturition, etc. Dr. S. V. Clevenger has since called attention to other inconveniences resulting from man's escape from his quadrumanous ancestors. In a paper entitled "Disadvantages of the Upright Position" he dwells particularly on the valves in the veins to assist the return of blood to the heart, which considered from the usual teleological point of view seems right enough; but why, he asks, should man have valves in the intercostal veins? He shows that in a recumbent position these valves are an actual detriment to the flow of blood. "An apparent anomaly exists in the absence of valves from parts where they are most needed, such as the venæ cavæ, spinal, iliac hemorrhoidal and portal. The azygos veins have imperfect valves. Place man upon 'all fours' and the law governing the presence and absence of valves is at once apparent, applicable, so far as I have been able to ascertain, to all quadrupedal and quadrumanous animals. Dorsad veins are valved; cephalad, ventrad, and caudad veins have no valves." By means of two simple diagrams he shows clearly the distribution of valved and unvalved veins as they exist in mammals, and why in man the same arrangement becomes detrimental. He dwells on the number of lives that are sacrificed every year by the absence of valves in the hemorrhoidal veins. He also mentions other disadvantages in the upright attitude, as seen in the position of the femoral artery, even with man's ability to protect it. Its exposed condition is a dangerous element. Inguinal hernia, of rare occurrence in mammals, occurs very often in man; at least twenty per cent. being affected. Strangulated hernia also causes many deaths. Prolapsus uteri and other troubles and diseases are referred to by Dr. Clevenger as due to the upright position In other words, the penalties of original sin are in fact the penalties resulting from man's assumption of the erect posture.

In another paper by the same author, on the "Origin and Descent of the Human Brain," he gives an interesting sketch of the phylogenesis of the spinal cord to its ultimate culmination in the development of the brain of man. He says that the most general interest centers in the large mass of cells and nerve fibers called the cerebrum. ' In the Ornithorhynchus, it is smooth and simple in form, but the beaver also has an unconvoluted brain, which shows at once the folly of attaching psychological importance to the number and intricacy of folds in animal brains. With phrenology, which finds bibativeness in the mastoid process of the temporal bone and amativeness in the occipital ridge, the convolutional controversies must die out, as has the so-called science of palmistry, which reads one's fate and fortune in the skin folds of the hand."

Prof. Alexander Graham Bell has presented a memoir to the National Academy on the "Formation of a Deaf Variety of the Human Race," in which he shows by tables a series of generations of certain families in which, the progenitors being deaf mutes, this peculiarity becomes perpetuated in many of the descendants. Recognizing fully the laws of heredity, natural selection, etc., he shows that the establishment of deaf mute schools, in which a visual language is taught which the pupils alone understand, tends to bring them into close association with each other, and that naturally with this seclusion acquaintance ripens into friendship and love, and that statistics show that there is now in process of being built up a deaf variety of man.

Dr. W. K. Brooks, animated by the cogency of Professor Bell's reasoning, is led to prepare an article entitled "Can Man be modified by Selection?" In this paper he discusses the startling proposition of Professor Bell, and recognizes the convincing proof which he furnishes to show that the law of selection does place within our reach a powerful influence for the improvement of our race. The striking character of the tables of facts presented by Professor Bell, and the significant suggestions of Dr. Brooks, lead one to consider how far the influence of selection has had to do with the character of great communities, as to their intelligence or ignorance. When we see nations of the same great race stock, one showing a high percentage of illiterates, a high death rate, degradation and ignorance, while just across the borders another nation, apparently no better off so far as physical environments are concerned, with percentage of illiterates and death rate low, a majority intelligent and cleanly, we are led to inquire if here a strict scientific scrutiny with careful historical investigation will not reveal the cause of these conditions. Can it be proved beyond question that the illiteracy and degradation of Italy and Spain up to within recent years, at least, is the result of centuries of church oppression and the Inquisition, destroying at once or driving out of the land all independent thinkers and at the same time forcing her priests to lead celibate lives and inducing others of cultivated and gentle minds to lead cloister lives? Is it also a fact, as Alphonse de Candolle asserts, that by far the greater number of distinguished scientists have come from Protestant pastors? He gives a significant list of eminent men whose fathers were Protestant pastors, saying that had they been priests of another religion, leading celibate lives, these men would not have been born.

It is considered an intrusion into matters which do not concern science when such inquiries are made, but the scientist has very deeply at heart the intellectual and moral welfare of the community. If the cause of degradation and ignorance, of poverty, of contagious disease, or of any of the miseries which make a nation wretched, can be pointed out by scientific methods, then it is the stern duty of science to step in and at least show the reasons, even if the remedy is not at once forthcoming. The men who would be reformers and agitators, and who by their earnestness and devotion get the attention of multitudes, are unfit for their work if they show their ignorance, as most of them do, of the doctrines of natural selection and derivation.

Dr. C. S. Minot read a paper before the Cincinnati meeting of this association suggesting a rather startling proposition as to whether man is the highest animal, which led Dr. W. N. Lockington to reply in a very able article entitled "Man's Place in Nature."

The great problem of food supply has led to legislative enactments for the purposes of regulating the trapping and netting of game and fish. State and government grants have been made for fish commissions; but unless the public are clearly educated in the rudiments of zoological science and the principles of natural selection, appropriations will come tardily and in limited amounts. Dr. W. K. Brooks, in his report to the State of Maryland as one of the oyster commissioners, after showing the absurd way in which the problem of oyster protection has been dealt with, and strenuously urging the necessity of oyster culture, calls attention to the fact that "civilized races have long recognized the fact that the true remedy is not to limit the demand, but rather to increase the supply of food, by rearing domestic sheep and cattle and poultry in place of wild deer and buffaloes and turkeys, and by cultivating the ground instead of searching for the natural fruits and seeds of the forests and swamps."

Mr. Ernest Ingersoll, author of the "Report on the Oyster Industry," 10th U. S. Census, has, in an address before the Geographical Society of New York, a striking sketch of the effect of the white man on the wild animals of North America, showing that had the Indians remained in possession, little, if any, change would have taken place. The Indian, like the predaceous animal, hunts only for food, and shows even in this habit a wholesome self-restraint, never killing wantonly. He called attention to the survival of a number of small birds about the dwellings of man as the result of favorable conditions, such as a constant supply of food, etc. He shows that the contact of man in the main has been disastrous. His remarks on the oyster are timely. He shows its extermination along the coast by man's agency. "Hardly more than a century has elapsed since men believed that the oyster beds of New York were inexhaustible and that a small measure of legal protection, feebly maintained, was quite enough to sustain them against any chance of decay. So they thought in Massachusetts, where the oysters have not only disappeared, but have been forgotten. So they think now in Maryland and Virginia, where their fond expectations are destined to equal downfall."

Prof. William A. Brewer, in a paper on the "Evolution of the American Trotting Horse," shows that the trotter is an American product, and that it is still in process of evolution. He gives a column of figures to show the speed that has been attained in this new form of motion, from a speed of three minutes in 1818 down to two ten and a quarter minutes in 1881. The materials for a curve are offered to mathematicians, and Prof. Francis E. Nipher, in a mathematical article on the subject, shows that a definite time of ninety-one seconds will ultimately be attained by the American trotter. Prof. W. H. Pickering, however, urges some objections to the deductions of Professor Nipher.

In drawing to a close this very imperfect summary of what American zoologists have accomplished for evolution, many other distinguished contributors might have been mentioned. The work of eminent physiologists and paleontologists has hardly been considered, nor has the long array of botanical facts for Darwin as revealed in the fascinating study of the relations which exist between flowering plants and insects, contrivances for cross fertilization, means of plant dispersion, etc., and the distinguished botanists connected with this work, received attention here. Indeed, the proper limits for an address of this nature have been far exceeded.

Suffice it to say that all these students have worked from the standpoint of derivative doctrines. A still greater triumph to Darwinism are the evidences of gradual conversion still going on among a few isolated workers who still remain stubborn, yet yielding to the pressure of these views by admitting features that, ten years ago, they repudiated.

There are two points to be emphasized here in closing, and one is that American biological science stands as a unit for evolution, and the other is, the establishment of a great generalization which shows that when intelligence became a factor in animals it was seized upon to the relative exclusion of other characteristics. This generalization offers an unassailable argument to-day for a wider, broader, and deeper education for the masses. The untold misery and suffering of the working classes as witnessed in their struggles of the last two years would have been avoided had the rudiments of social science—even a knowledge of the value and significance of simple statistics—been appreciated by them.

The startling paper of Dr Seaman, on the "Social Waste of a Great City," shows the blundering, criminal way in which municipalities are controlled by coteries ignorant alike of science and the beneficent mission she stands waiting to enter upon.

THE FLORENTINE STRAW INDUSTRY.

An account is given in the report just issued by Consul-General Colnaghi of the Florentine straw industry. It is stated that this industry was originally confined to the *Contado* of Florence, where it existed in the 16th century. From this district it gradually spread into other parts of Tuscany and of Italy. The industry appears, however, to have become of importance only at the beginning of the 18th century, when Domenico Michelacci introduced or perfected the culture of spring wheat (*grano marzuolo*), sown thickly, from which an excellent straw is obtained. The first experiments were made on the hills round Signa, and their success caused this culture to be quickly extended to the neighboring districts.

The industry now is so generally extended throughout the Florentine district that there is scarcely a family in which some of the members are not engaged in this work. Children begin to plait at five and six years of age, while the mothers of families, in addition to their domestic occupations, and females of all ages and almost of all conditions, who do not follow the business as a means of livelihood, employ their leisure time in it. Formerly, when the production was carried on by persons connected with agricultural labor only, the work was not constant, but now it goes on all the year round. In the cultivation and preparation of the straw, the seed used is carefully selected with regard to the nature of the soil in which it is to be sown. The quality employed is always a variety of spring wheat (*Triticum æstivum*).

As the object of the cultivator is to produce a fine long straw, and not a full crop of wheat, all the usual conditions are reversed. Thus a spring wheat is sown in winter, a mountain variety on low lands; the seed is thickly instead of thinly sown, etc. The thicker the seed is sown, the finer the straw comes out. Straw is largely grown about Campi, Sesto, and Prato, in the plain between Florence and Pistoia, diminishing in quantity in the neighborhood of the latter city. The cultivation is important between Florence and Empoli, principally on the southwest side of the Arno, on the plain, and on the hills commencing in the vicinity of Signa. In the principal centers of cultivation straw is grown on nearly every farm. Plots of land are also hired at a money rent for this culture. The seed is sown very thickly toward the end of November or the beginning of December. The ground is dug up and manured in May, and generally sown with spring beans and the like, which are often dug in. About October the ground is plowed for sowing, and at the end of May or the beginning of June following, when the ear is beginning to swell, the straw is pulled up by hand, a sunny day being chosen for the operation. The straw is then made up into bundles containing as much straw as can be easily held in the hand, and these bundles are tied up with broom. The gross produce of a hectare of land, the hectare being equivalent to about 2·47 acres, is calculated, approximately, at from 19,000 to 20,000 *manate* or bundles.

The next operation which the straw undergoes is that of being bleached, which is effected by exposure to the sun by day and to the dews by night. The bundles are spread in fan shape on a bare river bank or other open space, which must be entirely devoid of vegetation. After four or five days' exposure the straw will have acquired a light yellow color. The bundles are then turned over, and the under part exposed in its turn for three or four days more, when the straw, after being well dried, is gathered in. When the dews are light, the process is slower but more perfect. In case of rain, the straw is at once heaped together, and covered over to prevent its becoming spotted. The straw is now ready for manufacture, the first operation of which is the *spilatura* or unsheathing the ends, leaving only the inner portion to be worked up. This is generally done by children. When unsheathed, the straw is carried to the factories, and after having been slightly wetted it is first exposed to the fumes of sulphur in a tightly closed room. The straw has next to be sorted according to its different thicknesses. This is done by means of an apparatus which consists of a series of vertical metal cones placed on a stand in a double row, and provided with movable copper plates perforated at their lower ends. The holes in each succeeding plate are a size larger than those in the preceding one. The numbers generally range from 0 to 13, but sometimes they run up to 20. 0 represents the finest stems. A bundle of straw being placed in the first tube of the series, a saltatory movement is given to the machine by means of a combination of cog wheels, generally worked by hand. The finest straws pass through the holes of the plate, where they are suspended by the ear. The larger straws are then put into the next tube, and so on until the whole is assorted, a constant supply being maintained. The sorted straws which have passed into the holes up to the ends, by which they are suspended and prevented from falling through, are then drawn out by the ears and placed in separate receptacles.

The first thing after assorting the straw is to cut off the ears, an operation termed *spigatura*, which is done by a special machine. Then follows the *spilatura*, or assortment into lengths, which is effected by placing on a table a small cylindrical tin case, open at both ends, and about eight inches in height and eight inches in diameter, into which a loose bundle of the prepared straw is placed vertically. The operator sweeps his hand over the bundle, and draws up from it the longest straws, which project above the rest. These he deposits in the first compartment of a table furnished with different divisions. He then draws from the bundle the next longest straws, and so on until he comes to the shortest. The straw is usually divided into five or six lengths for the finer kinds. The straw is of a better color, more consistent, and finer as it approaches the ear, the lower part, which is protected by an outer covering, being whiter and softer. Formerly this end was not used, but now it is employed for making all the articles that go under the name of pedal hats or pedal plaits.

The sorted straw is next made up into small bundles, which are bound together in a large packet, the point or upper ends being placed upward in two bundles, and downward in the other two. The united packet is now laid under a cutter, and being divided through the center yields four smaller packets, two of point and two of pedal straw, which are ready for the plaiter. The straw is given out to the plaiters either directly from the factory or through a factor, in bundles either sufficient to make a length of fifty yards of plait or a hat, as the case may be. Before being plaited, the straw is slightly wetted to render it more flexible. The hats are sewn either with waxed thread or with the fiber of a rush which grows on the marsh lands near Signa, and which is prepared for the purpose. On the plaits being returned to the factory, they are measured. The length being found correct, they are washed in potash water in order to whiten them, and occasionally they are cylindered to give them a polish. They are next wound upon a circular toothed frame of one yard in circumference, the teeth being to keep the strands of the plait evenly one over the other. They are then made up into packets of six or twelve pieces, or sometimes of twenty-four pieces, after which they are packed in cases for export. On the hats being brought to the factory, the loose straws are first cut from the brims, and any defects in the plaiting are made good

by insertion, after which they are piled up on one another, and placed in large troughs full of potash water, in which they are pressed down by planks. They are then dried in the sun when the weather is fine, or in hot rooms when it is wet. The hats are then ready to be moulded into shape, which is effected by their being placed in heavy zinc moulds, and forced into shape by hydraulic pressure. They are next powdered with sulphur and polished with a small wooden instrument, and packed in cardboard boxes in dozens, and subsequently in wooden cases ready for export. According to the official trade returns, 18,000 cwt. of plaits and 3,399,000 straw hats were exported from Italy during the year 1885, chiefly to the United Kingdom, Switzerland, Germany, Austria, France, and North and South America.

SOME CURIOSITIES OF REFLECTION.

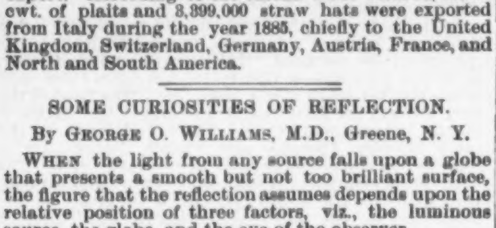
By GEORGE O. WILLIAMS, M.D., Greene, N. Y.

WHEN the light from any source falls upon a globe that presents a smooth but not too brilliant surface, the figure that the reflection assumes depends upon the relative position of three factors, viz., the luminous source, the globe, and the eye of the observer.

Thus it may take the form of a crescent defined upon that portion of the circumference that is nearest the light, as Fig. 1, A, or it may appear in any shape intermediate between this and a gibbous or a round. In fact, it may illustrate any of the moon's changes. Some portion of all the figures are, however, defined by the visible outline of the globe.

These are the reflection forms that a globe at rest exhibits. But if the light is reflected to the eye from a globe that is rapidly rotated on its axis, the figures assume entirely different appearances. The effect of the

Fig. 1.



rotation is to convert any superficial inequalities into continuous striæ or lines that are parallel with the equator of the globe and with each other. (Fig. 1, B.)

In order to conduct the following experiments, solid globes were made that were polished by lathe work and were moderately reflecting. The result for the purposes of the experiment was the same as if the globes were rotated.

The striæ produced need not be deep grooves. On a metal surface the microscopic lines of fine polish are sufficient to produce the desired effect. The striæ are really circular grooves. Their diameter is, of course, least near the pole and greatest at the equator. Each circle is a V shaped, annular sulcus, one face of which is directed toward the pole, the other toward the equator. One is a concave reflecting surface, the other a convex.

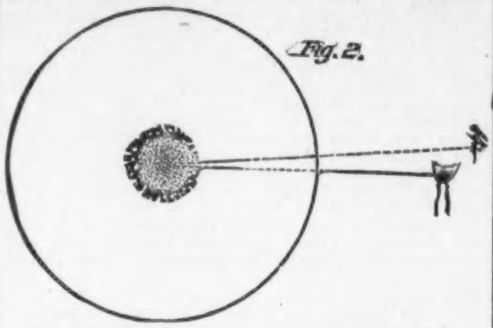
Now, if the pole of the globe is the point nearer the light and the eye, the small circles around it intercept and reflect less areas, but greater quantities of light, while the large circles at the equator reflect greater areas, but less quantities. The figure is prolonged, in consequence of the reflection of the diverging incident rays from the facets of the parallel striæ, and the curvature of the general surface disperses the greater portion of the rays in directions from the eye. Hence, the reflection from such a globe in the assumed position is a triangle of light brightest at the apex and faint at the base (Fig. 1, B). It may be of all lengths, from a mere triangular point to a large spherical sector reaching from the pole nearly or quite to the equator. The convex side is brighter than the concave. A hazy reflection of diverging rays also attends the figure, outlying it laterally and in front.

The bright apex is the reflection nucleus, the remainder is the reflection tail. Unlike the reflection from the globe at rest, the figure is seldom defined by the apparent circumference of the globe, but falls at some point between it and the vertical meridian. It sometimes is, however.

Now if the light and the eye are very near each other, while the globe is at some distance from them, thus rendering the angle of incidence and reflection exceedingly acute, the pole being directed toward both, the reflection appears as a disk of light surrounding the pole. It has a bright center, its margin is dim, there is no tail, but the equal reflection from every portion of each stria around the pole gives a central nucleus and a halo-like periphery (Fig. 2). The circles immediately around the pole give the intensest reflex because nearer the light.

Strictly speaking, if any angle at all exists, the reflection cannot be circular; but with a very acute angle the dispersion of rays in other directions than toward the eye is so slight that any deviation from a round appearance is scarcely perceptible. The reflection may be circular with no central nucleus (provided the source of the light is circular), if the projection is at the equator, the angle of reflection as acute as possible, and the axis of the globe perpendicular to a line from the equator to the eye. Reflections from different latitudes vary in shape, though toward the pole the triangle predominates. Its apex is always toward the pole. When near it, the apex is pointed; it becomes broader as the figure recedes from the pole. The nucleus in these instances is elongated. Now, if the parallel striæ are of variable depth and brilliancy, the deeper and brighter ones give, within the elongated nucleus, bright points of reflection. These points are arranged in a line corresponding to the meridian on which they occur. This line may therefore be either curved or straight, and the distances between them variable. Sometimes the points become transverse lines, brightest centrally.

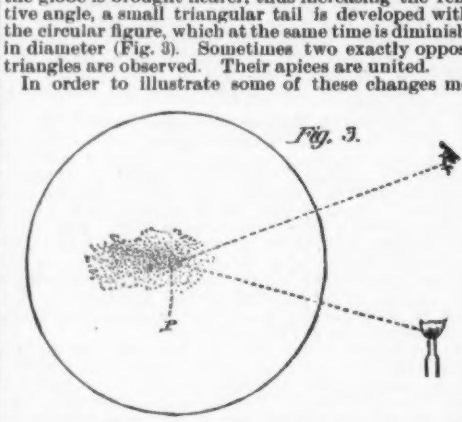
Fig. 2.



If, however, reverting to the polar circular figure, the globe is brought nearer, thus increasing the reflective angle, a small triangular tail is developed within the circular figure, which at the same time is diminished in diameter (Fig. 3). Sometimes two exactly opposite triangles are observed. Their apices are united.

In order to illustrate some of these changes more fully, it is desirable to assume for the globe certain arbitrary positions and directions (Fig. 4).

Fig. 3.



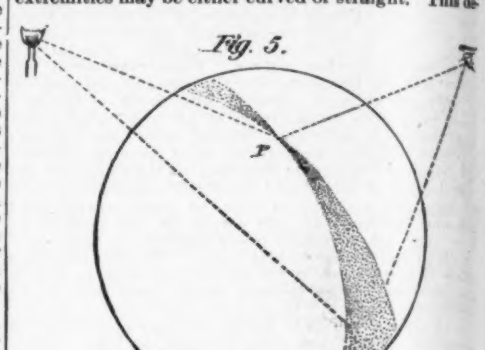
It is given an orbit around a light. For convenience, this orbit is an open ellipse. The light is placed at the focus. The axis of the globe is given an inclination to the plane of this orbit. This inclination in the same direction is preserved throughout the orbit. The striated globe thus represents a spherical mass that, while rotating on its inclined axis, is also revolving in an orbit which incloses a luminary. The eye is also given a position within the orbit, although this is inessential.

At the point, A, the reflection appears as a small faint circular figure defined around the pole proximal to the light and the eye. It has a central nucleus. At B the small triangular tail has appeared. The expanded extremity of the tail is directed away from the light. The reflection figure now increases in size and distinctness until at the point, C, it has reached its greatest development. The tail is fully formed, the nucleus displays its greatest brilliancy. This occurs just before it enters upon its *perilucion*, if a coined word is admissible. At the point, D, the reflection figure is obscured by the intenser light of the flame immediately near it, and between it and the eye, and is therefore lost to view. At E it reappears, but, owing to the axial inclination, the opposite pole is now proximal to the light and the eye, and hence the reflection nucleus appears at that point. The tail is, however, still directed away from the light, but in a direction somewhat opposed to that prior to the perilucion. From this point to F, the behavior of the reflection figure is the reverse of that prior to passing the light. It declines in distinctness and size until at F it has become again a faint, halo-like disk. Beyond this point it practically disappears. Observe also that the tail in the first half of its journey has been gradually rising above the orbit of the nucleus, which is indicated by the dotted line, N. This is an entirely different affair from the orbit assigned to the center of the globe as indicated by the solid line, M, although they are parallel.

As it rises, the curvature of the tail becomes greater, but at no time has it reached the circumference, but still falls within it. On the return track the tail gradually falls back to the direction of the orbit of the nucleus.

When the eye is external to the orbit, an endless variety of reflection figures occur. These may be straight with a central nucleus, as Fig. 8. The pointed extremities may be either curved or straight. This depends upon what meridian they are defined. The tail may be pointed and the nucleus large (Fig. 9). In such instances the reflection is from a point at or near the equator. The reflection figure may disappear after its perilucion, or it may be invisible prior, but visible subsequently. The tail may or may not be directed from the light. Oblate and ovate spheroids modify the figures. The reflections are much more effective when obtained from globes that greatly exceed the luminous source in size. The variations are endless and suggestive.

Fig. 5.



Hitherto, but one reflection figure has been considered. The truth is that from some point of view two diametrically opposite figures are always visible. (Fig. 5.) These opposite figures have a common nucleus, or rather, their apices touch at the pole of the globe. In a certain position of the three factors, these opposite sectors are equal. That is, the globe must be approaching from a direction continuous with its axis, and which, if prolonged, would intersect a line from the light to the eye. When equal, their convex sides are coincident with the apparent circumference of the globe, and hence serve to determine the dimensions of the globe. If unequal, they fall within it. All degrees of variation in the length of the minor figure, in fact, of both, occur. When very small, it gives to the greater figure the appearance of having a rounded head or nucleus, instead of a pointed; and if the globe is of good size and the striæ that encircle the pole have some depth to their walls, this rounded head will be found, if viewed through a camera, to be made up of incomplete rings or crescents, with their cornua directed backward toward the tail. Now, if the globe is moved slowly along, new annulations and crescents will be seen to develop in front of the head. On the other hand, if the translation is reversed, the crescents will disappear, the nucleus become pointed and gradually fainter as it recedes from the pole. The minor

Fig. 4.

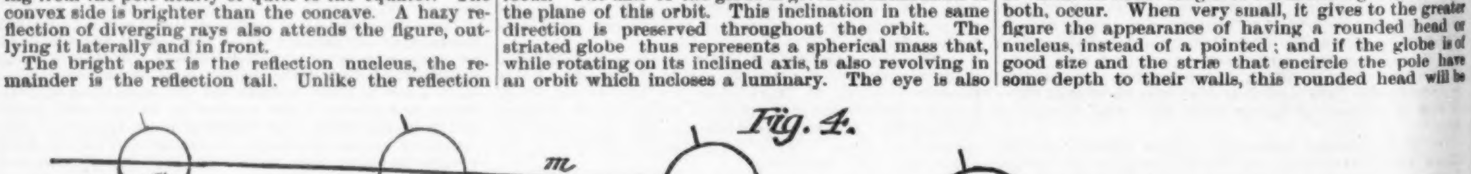
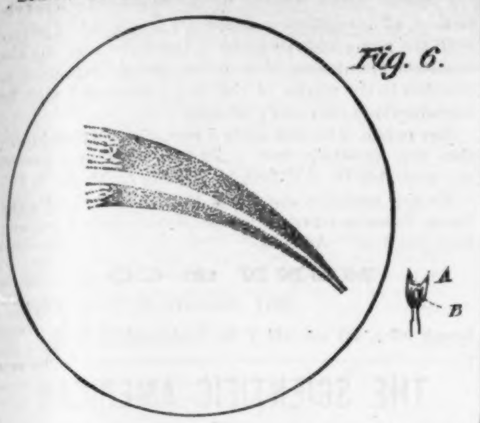


figure is now entirely invisible, but the tail of the greater has become much elongated. A still closer analysis of the reflection nucleus shows that it is also attended by a true coma, due to the reflection of divergent rays.

It will be noticed that similar causes produce the bright points in the elongated nucleus defined between the equator and the pole, and the crescents in the nucleus defined at the pole.

Sometimes the polar nucleus exhibits a triangle of

Fig. 6.

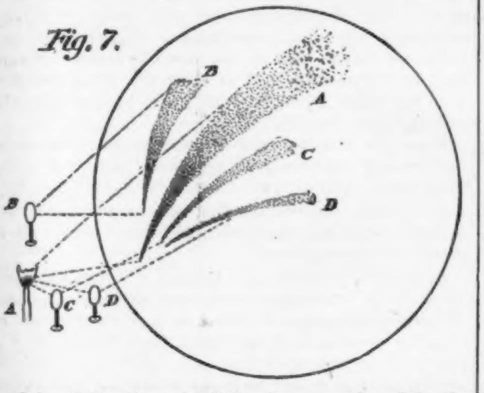


light. If there is limited oblation at the pole, this triangle has nearly rectilinear sides. Its apex is at the pole. If there is shallow, concave, circumpolar excavation, the triangle has deeply concave sides, the convex base is broad and adjacent to the concavity of the nuclear crescents. The basic angles are acuminate cornua directed backward toward the tail. The rounded nucleus is the final portion of the minor sector visible.

When an opaque body is placed upon the flame, it should not interrupt the continuity of the flame itself, the globe being at the same time in close juxtaposition to the light. A portion of the rays are, by it, shut off from the globe, and hence a longitudinal septum occurs in the reflection (Fig. 6).

It may partially or completely, equally or unequally, divide the figure. The position of the body on the flame in some measure determines the effect on the reflection. Very small bodies are sufficient to do this. Nothing smaller than one two-hundredths of the superficies of the flame itself has been employed in the experiments. The intercepting medium need not be perfectly opaque.

Fig. 7.

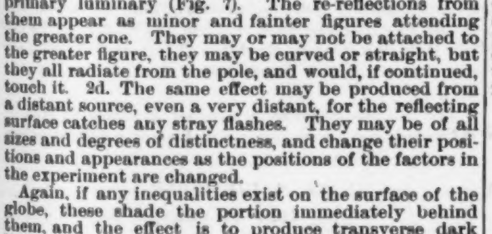


Multiple figures may be produced in two ways. 1st. By placing detached reflecting bodies adjacent to the primary luminary (Fig. 7). The re-reflections from them appear as minor and fainter figures attending the greater one. They may or may not be attached to the greater figure, they may be curved or straight, but they all radiate from the pole, and would, if continued, touch it. 2d. The same effect may be produced from a distant source, even a very distant, for the reflecting surface catches any stray flashes. They may be of all sizes and degrees of distinctness, and change their positions and appearances as the positions of the factors in the experiment are changed.

Again, if any inequalities exist on the surface of the globe, these shade the portion immediately behind them, and the effect is to produce transverse dark lines in the reflection figure, as in Fig. 10.

It is desirable to produce a reflection figure that shall have all the preceding characters and yet be transparent enough to permit brighter light to shine through

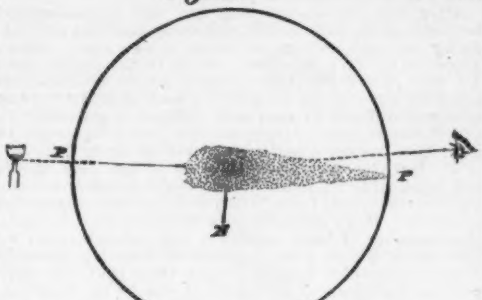
Fig. 8.



it. In order to accomplish this, a wire hoop was used (Fig. 11, A). Its diameter was 30 cm. It was made wholly non-reflecting, except its immediate circumference, which was slightly flattened and transversely grooved. By a simple mechanism it was rapidly rotated upon its diameter. The result was a large globe of extreme tenuity. This was placed before a dark curtain (Fig. 11—1, 2, 3, 4), which was studded with bright reflecting points. The flame was near the pole.

On rotating it, its outline was nowhere visible, except where the bright nucleus and long curved train was defined. This appeared suspended in mid-air, while the light from the bright points on the curtain shone through every part (Fig. 11, B). In fact, a very creditable artificial comet appeared. Indeed, throughout the experiments the appearances and behavior of the reflection figure are quite comet-like. If the experiments are carried still further, and a careful analysis of the nucleus made, the similarity is still more striking. Nothing, however, is claimed for the reflection figures. Whatever may be their import, they remain, for the present at least, simply curious coincidences.

Fig. 9.



Nevertheless, they are not accidental. They represent the reflections from a sphere revolving around a central luminary, and rotating on an axis inclined to the plane of its orbit.

They have been followed in legitimate sequence, and executed with the strictest deference to the laws of light and reflection.

Frankly stated, the following question was the incentive to the experiments:

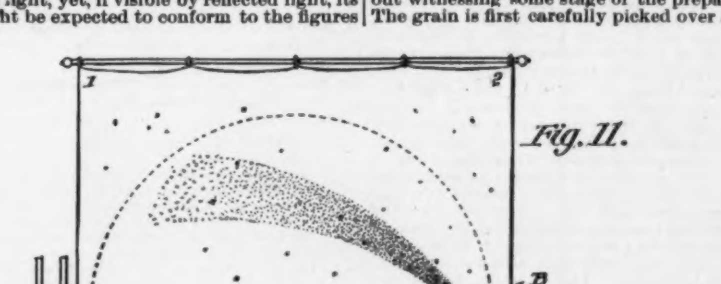
May a comet be the reflection of the sun's image from the exterior of an immense sphere of cometic matter—a nebulous planet, or, perhaps, simply a vortex setting

Fig. 10.

in motion the material lying in its path—that revolves around the sun and rotates on an axis inclined to the plane of its orbit?

It was thought that if such a sphere exists, its rotation might convert any external unevenness, either of density or elevation, and perhaps the larger of its discrete components, in effect, into continuous striæ parallel with its equator, and while it must be so exceedingly tenuous as to offer an imperceptible obstacle to transmitted light, yet, if visible by reflected light, its reflections might be expected to conform to the figures

Fig. 11.



on the striated or revolving globes in the experiments.

The globes were therefore given a miniature cometic orbit, and the analogy observed as represented. This analogy is by no means restricted to the few illustrations given, but it extends to all forms of comets that have come under observation, even to the minutest detail of nucleus, coma, or tail.

It occurred that the longitudinal septa of some comets might be caused by sun spots or some intervening medium that intercepts the light, and hence the opaque body was placed on the light. A corresponding division of the reflection figure appeared.

So too it was imagined that the smaller figures sometimes attending the cometic figure are the result of re-reflections from planetary bodies near the sun, or of stray light from a distant sun.

By imitating these conditions in the experiment, as nearly as possible, the reflections were made to represent the cometic appearances quite closely.

A newly executed experiment also illustrates the triangular dark space behind the nucleus.

It is unnecessary to prolong the comparisons, they are limitless.

Although it is improbable that astronomers could accept the theory of a *cometic sphere*, yet the reflections may have a meaning that will aid in reaching the truth. If they accomplish this, or even if they secure the attention of investigators, the object of this paper will be gained.

GOFIO: FOOD AND PHYSIQUE.

By C. FAYETTE TAYLOR, M.D.

ON a recent visit to the Canary Islands, one of the first things to attract my notice was the good development and fine personal appearance of the common people. I afterward found that travelers are generally impressed in the same manner on their first visit to the Canaries. If they have previously visited the Spanish peninsula, they are apt to contrast the native Spaniards with their Canarian relatives, always in favor of the latter, whose greater height and better bodily forms are very evident. This superiority may be due, in a certain degree, to the admixture of Spanish blood with that of the Guanche race, which was found in possession when, in 1440, the Spanish undertook the conquest of the Canarian archipelago. It required more than fifty years for the purpose, and not until to the utmost efforts of Spain, then in the height of her power, the treachery of four native kings had been added, did all the seven islands come under Spanish rule. The old chroniclers are fond of describing the mild and sweet dispositions of the Guanches, their tall, manly figures, and noble bearing in time of peace, as well as their great strength and valor when fighting to preserve their ancient liberty.

Even the women took part against the invaders, and proved themselves, in daring and prowess, no mean antagonists. One woman is especially mentioned who rushed upon an advancing column, seized the foremost soldier and fled up the mountain, bearing her victim as if he had been a child, outstripping her pursuers, till, coming to a precipice, she leaped down and both were dashed to pieces.

The conquerors not only mingled their blood with the conquered, as happens with the Latin races, but they adopted many of their customs, some of which are preserved to the present time. Perhaps the most important of these is in relation to their food, the principal article of which is of Guanche origin.

I have alluded to the excellent bodily development and proportions of the modern Canarians, and to the testimony left by the old chroniclers to the still fine characteristics of the ancient Guanches, who are indeed described as marvels of bodily strength, beauty, and agility, because these facts have an important bearing on the question of their food. As there can be no such bodily growth, strength, and activity as is described as belonging to these people without superior nourishment, it follows that the food used by the Guanches, and adopted and still almost exclusively used by the present inhabitants, must be highly nutritious.

This article, so evidently important, is the *gofio*, named at the head of this paper. There is nothing mysterious about it, for gofio is simply flour made from any of the cereals by parching or roasting before grinding. The Guanches may have roasted their wheat, barley, etc., by the ready method of first heating stones, on which or among which the grain was afterward placed. As to that there are no precise accounts, but well-shaped grinding stones are plentifully preserved. At present gofio is prepared by roasting the grain in a broad, shallow earthen dish, over a charcoal fire. It is kept constantly stirred, to prevent burning. One can hardly pass through a village or hamlet without witnessing some stage of the preparation of gofio. The grain is first carefully picked over and all impurities removed. The processes frequently take place in front of or just within the always-open door, giving the traveler ample opportunity to see all steps of the preparation. The grinding is done at the windmills, which abound everywhere. The roasted grain is ground to a very fine flour, when it becomes gofio. After grinding it is ready for immediate use. When it is to be eaten, milk, soup, or any suitable fluid may be mixed with it—anything, in fact, to give it suf-

ficient consistency to be conveyed into the mouth. Being already cooked, it requires no further preparation before eating.

Ultimately maize was introduced into the islands, and soon became an article of general cultivation, particularly on the island of Grand Canary, where gofio from it is the staple article of food for the laboring population, as that from wheat or wheat mixed with maize is in Teneriffe, wheat being more largely grown in the latter island. Gofio is also made from barley, and especially in Fuerteventura. It is also made from Spanish beans; but this kind is not used alone, but to mix in proportion of about one fourth to three fourths of wheat, barley, or maize gofio, as some prefer. Wheat and corn gofio, mixed in equal proportions, is very much used, and is preferred by many to either article alone. Nothing can exceed the extreme handiness of this ready-cooked article of food. The Canarian laborer, if alone, takes some gofio in a bag made of the stomach of a kid; if there are several persons, the skin of a kid is used. When the hour for the simple meal has arrived, the bag is extracted from some pocket, or, like enough, from the girdle, and putting a little water into it, after being well shaken, the meal is ready. Only enough water is added to make it sufficiently consistent to be readily taken in the hand, from which it is invariably eaten. The preparation occupies no appreciable time. The winter before last I saw one or two hundred Italian workmen repairing the retaining wall to a river, and had reason to admire both their industry and their simple, frugal habits. As the midday hour approached, one of a gang of ten or twelve men would step aside and prepare the dinner. It nearly always consisted of *polenta*, or Indian corn meal boiled in water. It took the best part of an hour to prepare it, and there was also the trouble of kettles, fires, providing wood, besides many antecedent preparations, even when cooking was thus reduced to its simplest proportions. The Canarian laborer has no such trouble. The roasting of the grain is more quickly done than cooking polenta, and can be prepared in larger quantity by the wife at home.

The grinding is the same in both cases, but gofio has the great advantage of being easily carried about the person in a bag, and is always ready to be eaten. It is also much more palatable. The Canarian Archipelago consists of seven inhabited islands with a population of 240,000 persons. From the best information I could get, I should think that fully 200,000 of them live almost exclusively on gofio, as their fathers have done before them, including their Guanche predecessors, from time immemorial. I have been thus particular in giving, in some detail, the origin, preparation, and importance of gofio in sustaining a large population, because I believe this article to be worthy of attention on the part of purveyors of farinaceous foods. If introduced into the United States, it would add a delicious, wholesome, and highly nutritious article of food, very convenient to use, to our already large variety. But gofio has other claims to our attention and favor than its economy, convenience, and evident highly nutritive qualities.

Finding it used, not only by the common people, for whom it constitutes the chief article of sustenance, as already stated, but also in the homes of the wealthier citizens, children being especially fond of and thriving well on it, I tried specimens of both wheat and maize gofio and found them very palatable—the maize especially so, having a delicious, aromatic flavor, which soon made me prefer it to bread, especially in the morning. Very soon gofio, with a soft-boiled egg, goat's milk and coffee, constituted a satisfactory breakfast. In fact, I liked it so well, and found it so digestible and nutritious, that I kept to it and throve on it till at the end of two months it occurred to me that during that time there had been no instance of "acid stomach," to which, in the best of times, I had always been subject. I left Teneriffe soon after, and during the voyage, and for some time after landing in the West Indies, the gofio breakfast was suspended. After some weeks without it, the acidity returned very severely, owing to exposure and fatigue. And, as usual, the acidity once established, persistency continued. After suffering several days, I thought of the gofio, a small quantity of which we had brought from Teneriffe. On eating it for breakfast, as I had done before, the acidity immediately disappeared and has not returned.

In this connection, I would say that I had previously observed the same phenomenon of complete exemption from acid stomach while using Carlsbad Zwieback, as the sole farinaceous food at breakfast. Zwieback, as most persons already know, is bread cut in thick slices and baked a second time. In Carlsbad the second baking is carried so far that the slice is browned through its entire thickness. If there remains a white central portion, it is not good, and will undergo acid decomposition in the dyspeptic stomach when the properly made Zwieback will remain for a long time unchanged except by gastric fluids. But while useful as a temporary expedient, Zwieback has not much nutrition after undergoing the three processes of raising, baking, and rebaking to incipient carbonizing. It is incapable of being used alone as a sufficient aliment. To gofio there is no such objection. The roasting is the first and only cooking of the food. Gofio is a food dry cooked, no fluid coming to it till the very moment of eating it; and we know that dry heat produces changes in the structure and composition of cereals different from those produced by moist heat. The roasting process is essentially different from the steaming, baking, or boiling process, and, for one thing, converts starchy particles into more soluble and more friable forms. Moderately browned bread crust illustrates the change produced.

Perhaps the roasting process has a protecting efficacy against the action of the ferments which are always present in the alimentary tract, ready to effect some form of decomposition should digestion be long enough delayed to allow them to act. In fact, there is no doubt that in many cases the stomach actually becomes a receptacle for the cultivation of microbes. As one meal after the other is taken into the stomach, each succeeding mass of fermentable material is affected by the ferment germs developed and energized by those which have preceded it, till a high degree of potency is reached as in the usual method of bacteria cultivation. In such a case, normal digestion is anticipated by fermentation, the wholesomeness of the food is impaired by antecedent decomposition, the gastric power is lessened by contact with noxious acids and gases, and we have the confirmed dyspeptic. The worst of it is that such a condition is self-propagating, all ordinary means failing to energize digestion or to de-energize the ferment that the former may precede the latter in the usual way. Even the useful and often indispensable stomach pump sometimes fails to prevent prompt fermentation of the first food taken after its careful use for cleansing purposes. In all my previous personal and professional experience, I found, when once the rapid acidulation of the food demonstrated the potentialization of the microbic ferment, there was no sure way to overcome it as, in turn, to energize the digestive action by prolonged absence from food. In that case, the ferment becomes itself digested and de-energized and acts more slowly than the digestive process.

After this the ever-present but now non-energized ferment germs act tardily, till some accident of over-doing, or bad eating, or other cause, again delays digestion till fermentation is set up in the gastric cavity, and the cultivation process above described is renewed, when there is another attack of acidity of the stomach, difficult to bear and difficult to get rid of, as every unfortunate dyspeptic and every unfortunate physician to such a patient full well know to their sorrow. But the starving-out process is not easy, and is not applicable in many cases; besides, not every one has the resolution for it, when it might be proper and effective. If, in gofio, already demonstrated to have the essentials of high nutrition and palatableness, we have an article of food capable of resisting the acid decomposition for a much longer time than the ordinary preparations of farinacea, it will be an inestimable boon to all civilized communities to make the fact known to them.

I have set on foot trials of the value of gofio, in such cases as are appropriate to carefully determine its influence in preventing gastric acidity. Whether the impressions formed, as above described, after several months' personal experience, are to be sustained or to be found groundless, will be known in due time by ample clinical demonstrations. But, considering the importance of the subject to so many persons, and to the end that experiments in the use of gofio in appropriate cases may be multiplied, I do not hesitate to place my (as yet) unsupported personal experience before the profession and public for their careful consideration.—*The Popular Science Monthly.*

M. GAREL has invented an electrical method of preparing paper stencils for letters, circulars, etc. In this apparatus a piece of very thin paper rests on a carbon block connected with one pole of a small induction coil, while the style, with which the writing is done, is connected with the other pole. On using the apparatus a series of sparks pass between the style and the carbon block, perforating the paper, which can then be used as a stencil in the ordinary way.

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TABLE OF CONTENTS.